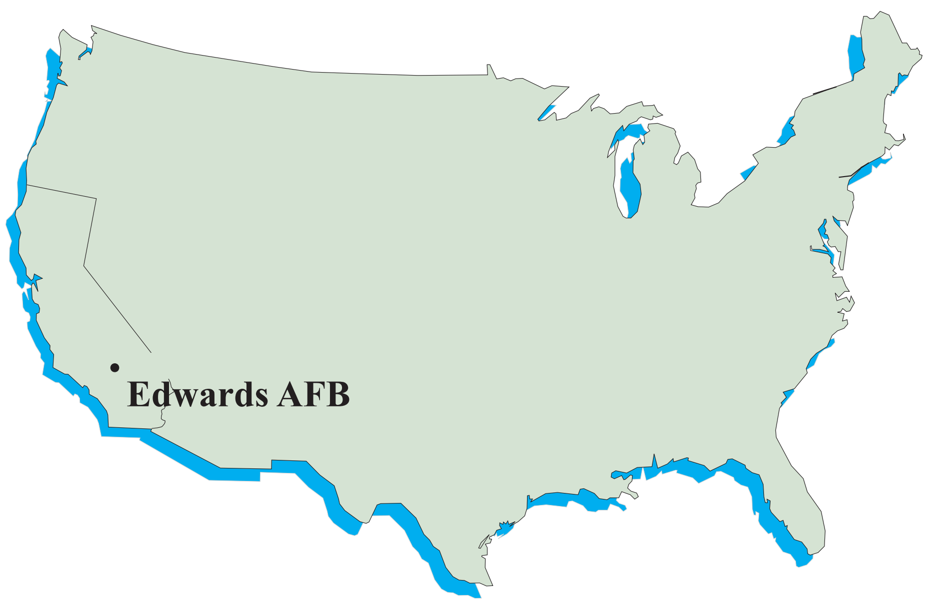
95th Air Base Wing
Air Force Flight Test Center
Edwards Air Force Base, California

ENVIRONMENTAL ASSESSMENT FOR THE TESTING AND EVALUATION OF DIRECTED ENERGY SYSTEMS USING LASER TECHNOLOGY AT EDWARDS AIR FORCE BASE



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FINDING OF NO SIGNIFICANT IMPACT FOR TESTING AND EVALUATION OF DIRECTED ENERGY SYSTEMS USING LASER TECHNOLOGY AT EDWARDS AIR FORCE BASE

1.0 INTRODUCTION

The U.S. Air Force proposes to test and evaluate low, medium, and high power directed energy (DE) systems using light amplification by stimulated emission of radiation (laser) technology at Edwards Air Force Base (AFB), California, and within the R-2508 Complex. All targets will be physically located on or above Edwards AFB, inside the restricted area R-2515. Up to 100 acres could be designated for target areas; however each individual target area would be limited to 5 acres. The Proposed Action is being developed to support the Air Force goal of meeting future requirements that are considered necessary for the defense of the territorial United States.

The Proposed Action will support the testing and integration testing of laser systems on aircraft and other delivery platforms which is considered one of the primary functions of the Air Force Flight Test Center, Edwards AFB, California.

2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES CONSIDERED

The Proposed Action would authorize the Air Force Flight Test Center to conduct up to 140 flight tests (including chase aircraft) and 24 ground tests beginning in 2006—increasing to up to 394 flight tests (including chase aircraft) and 24 ground tests in 2010—for low, medium, and high power laser systems. Alternative B would limit the test to using surrogate laser systems (very low power), and Alternative C, the No-Action Alternative, would limit the events to those previously authorized under the Airborne Laser (ABL) test program.

3.0 ENVIRONMENTAL CONSEQUENCES

The Region of Influence (ROI) of the proposed project consists primarily of Edwards AFB, restricted area R-2515, and the R-2508 Complex. The ROI for each alternative is discussed in terms of two distinct regions: (1) restricted area R-2515 (airspace) and the land under the airspace (Region 1) and (2) R-2508 Complex (Region 2). Impacts were reviewed for effects occurring on Edwards AFB and on the areas surrounding.

Resources within the ROI have been identified and evaluated under the following categories: air quality, airspace, cultural resources, environmental justice, geology and soils, hazardous waste/hazardous materials, infrastructure, land use, natural resources, noise, public/emergency services, safety, socioeconomics, and water resources. No potentially significant impacts were identified to any of these areas under the alternatives considered based on the proposed mitigation measures. This finding was based primarily on the fact that:

• The limited number of flights would be less than 2 percent of the current activity.

• The laser target areas (LTAs) would be evaluated by 95 ABW/CEV and other organizations to ensure mitigation measures were in place prior to testing events. The *Biological Opinion for Continued Use of the Precision Impact Range Area (PIRA)* allows for removal of desert tortoise critical habitat on the PIRA in support of this type of activity as long as it does not exceed 5 acres per site or a cumulative total of 100 acres.

• Laser hazard zones would be established to prevent non-participating receptors from entering the target areas.

Decisions regarding the significance of impacts, as defined under National Environmental Policy Act of 1969 (NEPA), are based on a consensus of the interpretation of environmental laws, rules, and regulations by cognizant federal, state, and local agencies; previously certified environmental documentation for similar projects; and trained and experienced professionals in each environmental field.

Cumulative Impacts

Alternatives A, B, or C would have no cumulative impacts to airspace, land use, noise, or to any other issue area analyzed in this Environmental Assessment (EA).

Short-term Versus Long-term Productivity of the Environment

No new construction or other development would be required under the Testing and Evaluation of Directed Energy Systems Using Laser Technology Program and current Air Force or contractor personnel from other bases would be used for the program. Neither Alternative A, B, nor C would involve any short- or long-term changes in population or productivity of the environment.

Irreversible and Irretrievable Commitments of Resources

This EA only addresses the test and evaluation of laser systems at 5 selected LTAs. Designating these sites for integration testing would not require an irreversible or irretrievable commitment of resources. The use of other sites in any of the Management Areas on Edwards AFB would be evaluated on a case-by-case basis to determine if irreversible and irretrievable commitments of resources were required. Irreversible or irretrievable commitment of resources that would be involved in other phases of the program (e.g., laser system fabrication and transportation to the site) would be addressed in separate environmental documentation. Implementation of Alternative C (No-Action Alternative) would also not require an irreversible or irretrievable commitment of resources.

4.0 CONCLUSION

On the basis of the findings of the EA, no significant impact to human environment would be expected from implementation of the Proposed Action. No additional mitigation measures are recommended. Therefore, issuance of a Finding of No Significant Impact is warranted, and preparation of an Environmental Impact Statement, pursuant to the NEPA (Public Law 91-190) is not required.

Background information that supports the research and development of this FONSI and the EA are on file at Edwards AFB and may be obtained by contacting:

95 ABW/PAE
Environmental management
Attn: Mr. Gary Hatch
5 E. Popson Avenue, Building 2650A
Edwards AFB, California 93524-8060
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James E. Judkins

JAMES E. JUDKINS, NH-IV
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10 Aug 06
Date

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

This Environmental Assessment (EA) evaluates the potential environmental impacts associated with the proposed test and evaluation of low, medium, and high power directed energy systems using light amplification by stimulated emission of radiation (laser) technology at Edwards Air Force Base (AFB), California, and within the R-2508 Complex. Directed energy systems include laser, high power microwave, and charged or particle beam systems. The most mature directed energy technology is the laser. This EA will only focus on laser systems.

This EA was prepared in accordance with the requirements of the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code 4321 *et seq*.); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] 1500–1508); 32 CFR Part 989, *Environmental Impact Analysis Process*; and other federal and local regulations. The U.S. Air Force Flight Test Center (AFFTC) is representing the Department of Defense as the lead agency.

2.0 PURPOSE AND NEED

The purpose of the Proposed Action is to conduct test and evaluation of the complex laser aircraft/weapons systems of the future at the AFFTC. The mission of the AFFTC has developed from a high performance aircraft flight test facility in the 1950s and 1960s to that of a high technology test and evaluation center for complete aircraft/avionics systems. Thus, laser testing is a continuation of the evolving primary mission of the AFFTC and is fully in accord with that mission as it has advanced since the 1940s.

An aircraft weapons system today is a tightly integrated system of airframe, engine, avionics (sensors and communications systems), and weapons. Current weapons are so integral to the avionics and sensor suite of the aircraft that it is impossible to test any part of the system (aircraft, avionics, or weapon) individually.

As laser systems (communications and weapons systems) continue to mature, they will also become an integral part of the complete aircraft system. New and existing aircraft need to be tested and their systems integrated with laser components and other components of the aircraft system. It will become impossible to conduct a thorough test of the airframe, the engine, or any of the avionics suite without also being able to operate the laser system. Laser-equipped aircraft of the future will likely become so tightly integrated that the flight controls, the aircraft sensor suite, and all pilot/cockpit interfaces will be tested in concert.

The Proposed Action is being developed to support the Air Force goal of meeting future requirements that are considered necessary for the defense of the territorial United States. This document serves as a programmatic assessment of the environmental effects and any mitigation that may be required to test and evaluate a variety of laser technologies at Edwards AFB and the R-2508 Complex. The period identified for this test program begins in 2006 and ends in 2010.

This EA addresses the launch, operational flight and ground testing, and landing phases of the intended laser test and evaluation program. Analysis of other phases (e.g., system design, production, and subsequent integration with operational forces) will be the responsibility of the individual system or aircraft program office. Edwards AFB is a cost-effective location for testing different laser technologies because of its facilities, its remote location, and its previous success and use as one of the nation's premier test and evaluation flight test centers. Thus, to continue providing the Air Force with a highly capable aircraft and aircraft weapons systems test and evaluation capability, it is essential that the AFFTC conduct test and evaluation of laser systems.

This EA analyzes and documents the affected environment and consequences of testing different types of laser technologies that can be used as the basis for future testing by other entities, but only if their technology is similar with respect to power levels and other criteria found in this report. Other civilian or commercial programs may have additional requirements beyond those imposed by the Air Force. It will be the responsibility of the civilian or commercial program office to identify and meet those additional requirements before testing at Edwards AFB can be authorized.

3.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

Alternative A, the Proposed Action Alternative, is to conduct low, medium, and high power laser testing within Region 1 and Region 2 in the ground-to-ground (G/G), ground-to-air (G/A), air-to-ground (A/G), and air-to-air (A/A) modes. Region 1 is defined as Edwards AFB (Management Areas A through G) and the airspace in restricted area R-2515, and Region 2 is the airspace within the R-2508 Complex. In addition to being tested in the G/G, G/A, A/G, and A/A modes, communications lasers would be tested in the low, medium, and high power settings for ground-to-space (G/S), space-to-ground (S/G), air-to-space (A/S), and space-to-air (S/A) modes.

Under Alternative B low power laser testing would occur within Region 1 and Region 2 for the G/G, G/A, A/G, and A/A modes, and medium and high power laser testing would occur inside test facilities and controlled areas of Edwards AFB. Controlled areas would include designated target boards and other targets in areas on Edwards AFB that meet specific safety requirements and for which there is a completed preliminary hazards assessment and an approved Air Force (AF) Form 813/332. Communication lasers would be tested in the low power setting in Region 2, and medium and high power settings inside test facilities and controlled areas of Edwards AFB.

Under Alternative C, the No-Action Alternative, the laser testing would continue based on the Airborne Laser (ABL) *Final Environmental Impact Statement for the Program Definition and Risk Reduction Phase of the Air Base Laser* (1997) and *Supplemental Environmental Impact Statement for the Airborne Laser Program* (2003); low power lasing of G/G targets would be limited to Management Area B in the Precision Impact Range Area (PIRA).

Edwards AFB has historically been selected as a primary testing site for new aircraft and new systems because of the remote surroundings. The open terrain and rock outcropping that can be used as backdrops for A/G and G/G testing are ideally suited for this type of test and evaluation activity.

Target areas located only on Edwards AFB would be limited to 5 acres per site, with a maximum of 100 acres total for the designated sites and future undesignated sites.

Developmental systems using next generation laser technologies are being tested and evaluated to determine their adaptability and suitability to military missions. Developmental systems are those systems that have progressed from the conceptual model to the developmental phase and require a period of further testing and evaluation before production is justified. Next generation developmental systems may require testing and evaluation of variants to current systems like the chemical oxygen-iodine laser (COIL) or other laser technologies. If hazardous laser energy were to leave the controlled airspace of the test range, atmospheric lasing events would require clearance from the U.S. Space Command (Laser Clearing House) and the regional Federal Aviation Administration (FAA) office. The laser parameters (wavelength, power, beam divergence, and vector [e.g., above the horizon]) are considered by these agencies when determining if approval for the lasing event will be granted. Developmental systems would be investigated as part of the proposed program to develop baseline information on beam characteristics and hardware properties.

3.1 ALTERNATIVES CONSIDERED AND DISMISSED FROM FURTHER CONSIDERATION

The Council on Environmental Quality regulations require that NEPA documents evaluate all reasonable alternatives, briefly discuss those alternatives eliminated from detailed analysis, and provide the reasons for elimination of any alternatives (40 CFR 1502.14[a]). "Reasonable is defined as practical or feasible from a common sense, technical, and economic standpoint" (51 *Federal Register* 15618, April 25, 1986).

Several alternatives were considered, but were not considered to be practical, feasible, or economically sound reasons for selecting them as potential alternatives.

- The testing of high power lasers fired from the warning areas off the coast of California was briefly considered but eliminated from consideration because of the potential constraints and impacts to population areas between firing positions and target sites.

- The testing of high power lasers fired from the R-2508 Complex to targets off the coast of California was also briefly considered but eliminated from consideration because of the potential constraints and impacts to population areas between firing positions and target sites.

3.2 NO-ACTION ALTERNATIVE

Alternative C (No-Action Alternative) is the status quo with low power lasing of G/G targets limited to Management Area B. Flight tests of the ABL using A/A targets would be performed within the R-2508 Complex.

Developmental laser systems like the ABL would continue to be tested and evaluated using the COIL as the power source. Laser simulations of the COIL would be tested in pressure chambers at the Birk Flight Test Facility prior to integration into the ABL system. The 1.315 micrometer wavelength generated by the COIL would continue to be evaluated to determine beam characteristics and ultimate power levels. The ABL systems would be ground tested by lasing to targets in the PIRA to calibrate the various laser systems with command and control software packages. Flight tests of the ABL system would be performed in the R-2508 Complex to test imaging and ranging capabilities against target boards attached to aircraft. Test and evaluation programs would use existing facilities and modify buildings on an as-needed basis. The programs would utilize the existing workforce, but the number of workers needed would increase depending on the magnitude and complexity of the testing programs.

4.0 SUMMARY OF ENVIRONMENTAL IMPACTS AND PROPOSED MITIGATION MEASURES

The analysis indicates that none of the impacts individually or collectively would be significant. Measures to protect the various resource areas have been incorporated into the description of each action alternative, and mitigation measures have been included to further address any potential effects on the environment. Notable mitigation measures include the following.

- Airspace. During laser test and evaluation activities, range personnel will be required to conduct visual inspections of the area to verify that personnel or aircraft had not entered the laser hazard zone. Laser test and evaluation mission aircraft will maintain an altitude of at least 3,000 feet above ground level near any airports or airfields to ensure that a laser free zone is maintained. Pilots in aircraft and ground personnel involved with the specific laser tests will be fitted with appropriate eye safe laser protection (goggles) to ensure there are no adverse impacts. If any test plan is developed that results in the laser beam projecting into space, the FAA and Laser Clearinghouse will be notified, and clearance to radiate will be granted prior to any lasing activities. The test planning process will be followed and appropriate organizations will be notified when testing the laser beams. The only laser devices that will be tested in space are communications lasers.

- Cultural Resources. Proposed laser target areas (LTAs) will be investigated by Environmental Management (95 ABW/CEV) to verify that cultural artifacts are not present prior to designating them as approved LTAs. Test plans involving ground targets at one of the Management Areas on Edwards AFB will be designed so that target impacts occur at one of the designated target sites on the PIRA, Air Force Research Laboratory, or an impact area on Edwards AFB that has been verified not to contain cultural artifacts. Recovery of the lased target from designated target sites will be in a way that minimizes ground disturbance and potential impacts to undiscovered cultural artifacts or sites on-base. Range personnel will use existing roads, whenever possible, to recover and transport lased targets for analysis. To ensure there is no impact to off-base cultural resources, flight tests will be developed to ensure laser energy avoids areas of critical environmental concern.

- Geology and Soils. All earthwork will be planned and conducted to minimize the duration that soils would be left unprotected. The extent of the area of disturbance necessary to accomplish the project will be minimized. Ground-disturbance activities will be delayed during high wind conditions (in excess of 25 knots [29 miles per hour]). Vehicular traffic, grading, and digging will not be permitted in the project area during high wind conditions. Use of off-road vehicles will be kept to a minimum. Whenever possible, the Air Force will use existing roads to access and establish LTAs.

  A digging permit (AF Form 103) will be required if digging is 4 inches or more below the surface. If fill material is required for the construction of targets, then all fill material will be obtained from an approved location.

  Construction activities have the potential to uncover unknown contaminated soil. In the event contaminated soil is discovered, the proponent will notify the 95 ABW/CEV, Environmental Management office, immediately. Contaminated soil must be removed in accordance with applicable federal, state, and local regulations.

  The target area will be cleared of any debris and before any additional laser testing is conducted in a particular target area. Therefore, no significant impacts on soil contamination and fate and transport would be anticipated.

- Natural Resources. Impacts to natural resources would include blading of roads and target areas, any improvements involving ground clearing for the reuse of existing target sites, and direct or indirect impacts from the laser testing. The effects of laser testing are expected to primarily affect birds; however, the size and duration of laser beam is expected to be so small/brief as to mathematically have almost no effect. As the intensity of the laser beam increases there may be other effects on natural resources from fires and reflection. The low probability of direct effects on wildlife includes both air-to-air test and air-to-ground tests. The blading and maintenance of the target sites will affect all plants and animals within bladed areas and indirectly affect organisms adjacent to the target site and access roads.

Two of the targets are located in Zone 3, desert tortoise critical habitat. Of these, two sites are also located within the Edwards AFB Desert Tortoise Management Area. The site at Mt. Grinnel has been constructed and the other site at Mt. Mesa has not. These two sites would reduce the best desert tortoise habitat by approximately 10 acres. Damage would also occur from fragmentation and degradation of the habitat. The Biological Opinion for the Precision Impact Range Area allows for disturbance of up to 5 acres per site with a maximum cumulative disturbance of 100 acres within Zone 3 desert tortoise critical habitat. The greatest and most direct effect of this project on desert tortoises would be caused by crews traveling on unpaved roads to the sites. Crews hauling portable target boards to the sites may encounter desert tortoises on the roads. They may either wait for the tortoise to leave the road or move the tortoise out of harm's way.

This project may affect sensitive plant species if the new target sites are located within population boundaries. Field surveys and a literature search will verify if the project will directly affect sensitive plant species. Prior to conducting any test and evaluation events associated with this Proposed Action or Alternatives, surveys will be conducted at the LTA(s) chosen for the test to determine if sensitive, threatened, or endangered species are in the immediate areas. Desert tortoises found within the project area will be removed from LTA(s) and firing points and placed in outdoor desert tortoise pens located in a natural environment for up to 7 consecutive days. If tortoise fences are installed around the LTA(s) and firing points, then this removal from the LTA(s) and firing points will be permanent. This removal action constitute a short-term effect to the tortoises and will be reported to the U.S. Fish and Wildlife Service. Relocating the tortoises out of harm's way will reduce the potential for disruption of their natural routine but may have long-term negative effects on local populations.

The following mitigation measures would be required for G/G, A/G, and G/A laser test and evaluation activities.

(1) All workers and visitors to work sites will receive a desert tortoise awareness briefing that defines their responsibilities and liabilities under the Endangered Species Act. Project personnel will notify 95 ABW/CEV, Environmental Management Division, at least 3 days prior to starting project activities to schedule briefings, pre-surveys, and monitoring.

(2) If a desert tortoise burrow is encountered within the LTA, the burrow will be avoided to the maximum extent practicable. If avoidance is not possible, an authorized AFFTC biologist will excavate the burrow according to the USFWS *Guidelines for Handling Desert Tortoises During Construction Projects*.

(3) Desert tortoises found aboveground within the project area will be temporarily moved out of harm's way by an authorized biologist according to the USFWS *Guidelines for Handling Desert Tortoises During Construction Projects*.

(4) During construction activities areas will be clearly fenced, marked, and flagged at the outer boundaries to define the limits of work activities. All workers will be instructed to confine their activities to the marked areas.

(5) Laydown, parking, and staging areas will be restricted to previously disturbed areas to the maximum extent practicable.

(6) Vehicles will, to the maximum extent practicable, remain on established roads. If this is not possible in the project area, an authorized biologist will survey the route to be traveled. Equipment and vehicle operators will be alert for desert tortoises and other wildlife in and along access routes. All desert tortoise burrows will be avoided during off-road travel. When traveling off-road, speed limits will not exceed 5 mph and shrubs will be avoided as much as possible.

(7) At no time will project personnel or site visitors harass, harm, or kill any desert tortoise. Project personnel or site visitors will not touch or move

any desert tortoise unless the tortoise is in danger of being killed or injured; and then only if they have been properly instructed and trained how to properly handle and move the desert tortoise and if a Base Biologist cannot be located. Workers and visitors will immediately report all desert tortoise sightings to 95 ABW/CEV, Environmental Management Division.

(8) Workers and site visitors will check under parked vehicles for desert tortoises and other wildlife species before moving vehicles. If a desert tortoise is found under a vehicle, the 95 ABW/CEV, Environmental Management Division, will be notified immediately so an authorized biologist can move the desert tortoise to a safe area.

(9) All trash will be placed in raven-proof receptacles for proper disposal to reduce its attractiveness to desert tortoise predators (e.g., coyotes and common ravens).

(10) All open excavations will have a ramp with a 3:1 slope at each end to facilitate escape of trapped wildlife. Excavations left overnight will be secured prior to leaving the site. Exclusionary fencing or plywood may be used to prevent wildlife from becoming trapped in excavations. Excavations will be inspected for trapped wildlife prior to backfilling. If any wildlife is trapped in excavations at work sites, the 95 ABW/CEV, Environmental Management Division, will be notified immediately.

(11) Stationary laser target boards will be inspected for active bird nests prior to lasing activities.

(12) Contact the 95 ABW/CEV, Environmental Management Division, at 661-275-2435 or 277-2017 if an active bird nest is found within the project area.

(13) The total allowable cumulative habitat disturbance for project activities located in Desert Tortoise Management Area Zone 3 is 100 acres. Siting

targets and conducting projects within Zone 3 will be avoided to the maximum extent feasible.

Laser targeting activities are performed at laser target areas approved by the Range Safety Office.

- Noise. Edwards AFB regularly monitors noise complaints (which are often just inquiries), which average less than 30 per year. Although noise complaints associated with laser test and evaluation are expected to be negligible, Edwards AFB will continue to monitor noise complaints as a normal part of community relations.

- Safety and Occupational Health. To minimize potential laser hazards, multiple controls will be used to reduce the potential for off-range lasing and accidental lasing of unsuspecting receptors. These controls will include the use of backdrops and enclosures, horizontal and vertical buffer zones, administrative controls, and removal of mirror-like reflecting surfaces from the test area. Prior to each laser test and evaluation event, the Range Safety Office (412 TW/ENROR) will complete a laser hazards evaluation. The Range Safety Office will use the LHAZ 3.0 program (or the most current Air Force laser hazard evaluation software) and record the information on an AF Form 2760, Laser Hazard Evaluation, or equivalent. Hearing protection will be required for personnel in the immediate vicinity of the ground pressure recovery assembly, associated ejector tubes, and aerospace ground equipment/ground support equipment during the ground test and aircraft launch activities in Region 1. Approval authority for activities using lasers lies with the 95th Operations Group, 412th Test Wing, or AFFTC Commander depending on the risk level of the test activity. The AFFTC Commander has final authority and responsibility for the safety of the proposed action.

- Water Resources. All earthwork conducted in the playa lakebeds will be planned and conducted when the lakebed is dry. If suggested mitigation measures for geology and soils are followed, then no additional mitigation measures for water resources would be required.

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1.0 PURPOSE AND NEED FOR ACTION

1.1 INTRODUCTION

This Environmental Assessment (EA) evaluates the potential environmental impacts associated with the test and evaluation of low, medium, and high power directed energy (DE) systems using light amplification by stimulated emission of radiation (laser) systems within the R-2508 Complex and at Edwards Air Force Base (AFB), California. Directed energy systems include laser, high-power microwave, and charged or neutral particle beam systems. The most mature DE technology is the laser. This EA will only focus on laser systems.

This EA is being prepared in accordance with the requirements of the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code 4321 *et seq*.); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal regulations [CFR] 1500–1508); U.S. Air Force Instruction 32-7061, *The Environmental Impact Analysis Process (EIAP)*; and Title 32 CFR Part 989, which implements these regulations in the EIAP, and other federal and local regulations. The U.S. Air Force Flight Test Center (AFFTC) is representing the Department of Defense (DoD) as the lead agency.

1.2 LOCATION OF PROPOSED ACTION

The Proposed Action would occur primarily on Edwards AFB (Management Areas B, E, and G) and within the R-2508 Complex. Edwards AFB is located in the Antelope Valley region of the western Mojave Desert in Southern California, about 60 miles northeast of Los Angeles, California. Portions of the Base lie within Kern, Los Angeles, and San Bernardino counties. The Base occupies an area of approximately 301,000 acres or 470 square miles and lies totally within the R-2508 Complex. The R-2508 Complex occupies an area of approximately 19,600 square miles, extending from 45 miles north of Los Angeles, California, to 10 miles south of Bishop, California. The boundary of the R-2508 Complex approaches the Nevada border on the east and Bakersfield and Fresno, California, on the west (Figure 1-1).

1.3 BACKGROUND

The United States has recognized that technologies applicable to the development and production of lasers and laser systems can be critical to the warfighting capability of its forces on the land and sea and

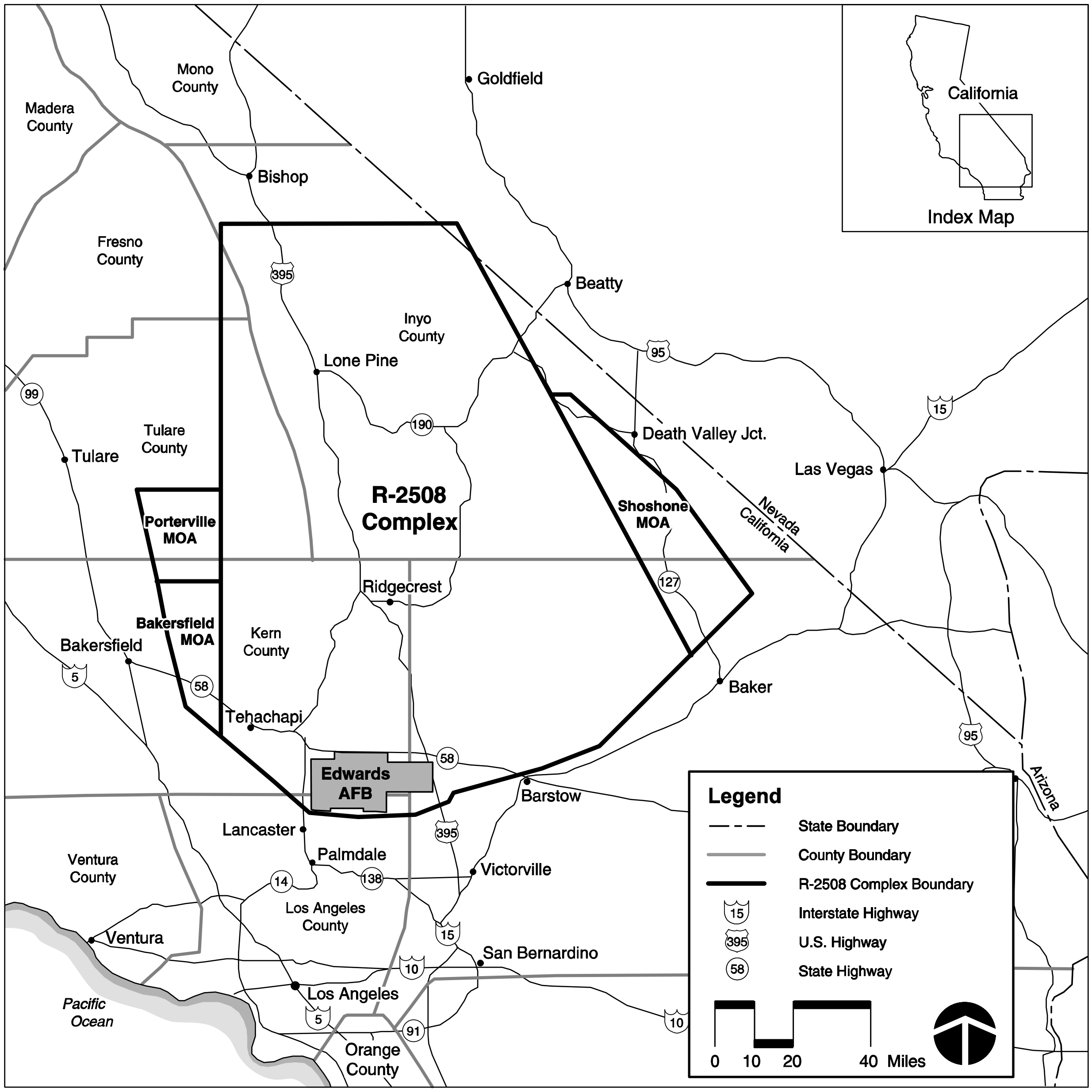


Figure 1-1 General Vicinity Map

in the air and in space. The use of laser systems can allow the United States maintain the advantage over our adversaries for the foreseeable future, with applications for all the armed forces throughout the battlefield and entire spectrum of war. These systems represent a "leap-ahead technology" that will have tremendous impact on the development of future joint and Air Force operational concepts and our military's ability to win decisively.

On June 6, 2000, scientists and technicians from the U.S. Army and Israel made history when they used a chemically fueled, high-power laser to destroy an incoming Russian-made Katyusha rocket with a live warhead on its nose. Since that date, over 40 Katyusha rockets have been destroyed during single and multiple launch and targeting events.

The *Air Force Transformational Flight Plan* (Flight Plan), published in November 2003, emphasized the importance of developing strategies and concepts of operation appropriate for this new era and of rethinking doctrinal approaches to organizing, training, and equipping our forces. The Flight Plan identifies key Air Force programs, Advanced Concept Technology Demonstrations, and future system concepts that the Air Force believes will likely be the key enablers of the transformational capabilities required for success. They include

- Deployment of a secure, robust, and wideband network. A major Air Force effort to deploy such a network involves new laser communications. Laser communications offer new potential for extremely high capacity as well as a secure means of communication using different frequencies and propagation methods. They are inherently jam-resistant, providing much greater security than typical wireless or wired communication systems. Systems like the TeraHertz Operational Reachback (THOR) would support this capability.

- Precision engagements. The Air Force recently completed a "Directed Energy Master Plan," which articulates its strategy to develop and transition DE applications such as precision engagements, information superiority, space superiority, and ballistic missile defense. Platforms like the Advanced Tactical Laser (ATL) are proposed to support this type of capability.

- Missile destruction in flight. One of the key components of Homeland Defense is the ability to protect the territorial United States from ballistic missile attack. The Air Force is pursuing transformational capability that comprises detection of ballistic and cruise missile launches and destruction of those missiles in flight. Platforms like the Airborne Laser (ABL) and Evolutionary Aerospace Global Laser Engagement would support this type of capability.

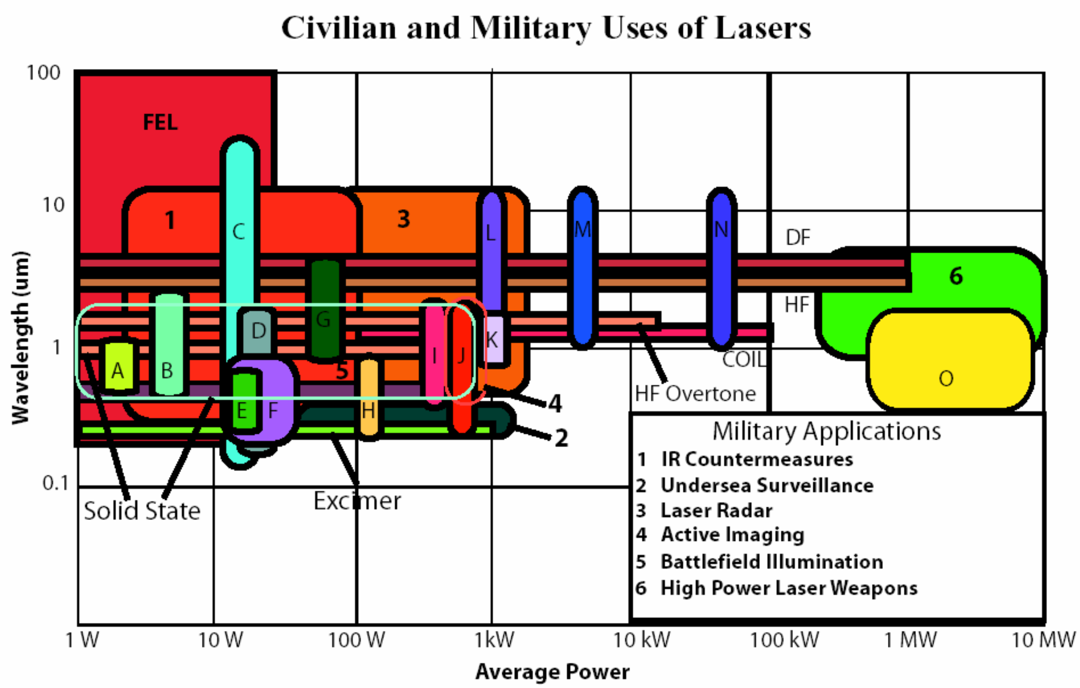
1.3.1 Directed Energy Systems

Directed energy is an umbrella term covering technologies relating to the production of a beam of electromagnetic energy or atomic or subatomic particles (DoD 2003). Directed energy is propagated from selected regions of the electromagnetic spectrum emitting radiation energies that have distinct wavelengths and frequencies. Research into DE has been in progress for decades. Understanding the mechanisms that propagate these energies, developing the systems that produce them, and characterizing their effects are the focus of current research and development by private industry and the military.

Directed energy is pervasive in the civilian and commercial worlds. Everyday uses of DE systems range from scanners at supermarket checkout counters to the laser surgery used to correct vision and/or remove or repair damaged tissue. Laser-based fiber-optic communications systems focus light down spun glass pathways; in other words, DE is sent along a confined path and is an integral part of the Internet and World Wide Web. Industrial lasers are used in a wide variety of businesses as measuring devices and as tools for cutting and shaping materials. Laser spectroscopy has allowed enormous advances in medical and material research, and such devices are essential equipment in any modern laboratory or research facility.

Starting in 1962, the Air Force began to take a lead role in DE and has committed to a vigorous program of experimenting, testing, and evaluating new operational concepts and developmental DE systems for air and space power. The application of DE technology as non-lethal weapons is allowing rapid changes in military strategies and operations. Because DE systems operate at the speed of light (about 300,000 kilometers per second), they have the potential to decrease the time needed for reaching operational objectives, and unlike many other technological advances, can be applied at virtually every level of military operations and conflict from peacekeeping to intercontinental warfare. Directed energy offers enhancements to military capabilities by potentially achieving objectives with minimal or no collateral damage to populations or to neighboring structures.

Speed, precision (focused power), and tunability (the ability to change the wavelength) are all, to a greater or lesser extent, inherent characteristics of DE systems that have made them desirable in both the commercial/civil and military environments. Speed and precision are also characteristics of computer systems that have allowed DE technology to move from theoretical to practical application (Lexington Institute 2003). Figure 1-2 illustrates the power and wavelengths of many commercial/civil and military DE systems (lasers) currently in use.



CIVILIAN APPLICATIONS

A	CD Player	F	Reprographics	K	X-Ray Lithography
B	Optical Fiber Comm	G	Tissue Cutting	L	Heat Treatment
C	Remote Sensing	H	Photodynamic Therapy	M	Cutting/Welding
D	Weather Sensing	I	Eye Surgery	N	Robotic Welding
E	TV, Entertainment	J	Circuit Repair and Marking	O	Power Beaming

Notes:

CD–compact disk

COIL –chemical oxygen iodine laser

DF – deuterium fluoride laser

Excimer– Excited dimer (diatomic molecule usually of an inert gas atom and a halide atom, which are bound in excited states)

(Excimer lasers operate in the ultraviolet wavelengths and may be considered as the third generation of industrial lasers.)

FEL–free electron laser

HF– hydrogen fluoride laser

HF Overtone – shorter wavelength laser that may achieve equivalent range performance with a smaller diameter beam director mirror.

IR–infrared

kW–kilowatt

MW–megawatt

W–watt

Source: Directed Energy Professional Society 2003.

Figure 1-2 Commercial/Civil and Military Applications of DE Systems

Use of DE systems in military applications is becoming more and more common. United States "smart weapons," which accounted for some 60 percent of all weapons employed in Kosovo and Afghanistan, are dependent on lasers, either to illuminate their targets or, in the case of global positioning system guided Joint Attack Munitions, on the use of laser range finders to precisely locate a target's coordinates. Laser range finders are key to operating virtually all modern, direct-fire weapon systems, including main battle tanks and attack helicopters.

The Air Force and other military services are investigating conceptual laser systems to determine their application as potential lethal or nonlethal weaponry on airborne platforms and ground-based stations. Laser systems that have reached the developmental phase require extensive testing and evaluation before production can proceed. Examples of developmental systems that are being investigated are the ABL, the ATL, and the THOR programs.

The ABL is a Boeing 747–based, multi-megawatt (one megawatt equals one million watts) laser platform that will engage and destroy ballistic missiles during their boost phase at hundreds of kilometers standoff range (Figure 1-3). The ABL will thus not have to penetrate into enemy airspace to accomplish its mission. Nevertheless, the ABL will be capable of limited self-defense since it will be able to track, target, and destroy surface-to-air missiles, air-to-air missiles, and threatening aircraft.

Figure 1-3 Artist Concept of the ABL

The ATL is an Advanced Concept Technology Demonstration (ACTD) program for a tactical high-energy laser (HEL) weapon system on an airborne platform (Figure 1-4). This Air Force Special Operation Command–acquired, jointly sponsored effort will demonstrate technology concepts to satisfy mission needs for an ultra-precision, standoff strike capability. In addition, specific ATL ACTD objectives include demonstrating a modular, high-energy laser weapon and the ability to acquire and engage tactical targets in an air-to-ground system test. Planning is in place and funding has been scheduled for an acquisition program in 2006.

Figure 1-4 Artist Concept of the ATL

The THOR program would establish a high-speed, global, broadband connection for air, ground, subsurface, and space communications (Figure 1-5). This network would be "fiberless fiber" capable of providing secure, assured, high data rate end-to-end communication for warfighters by developing, integrating, and demonstrating innovative optical system concepts and technologies.

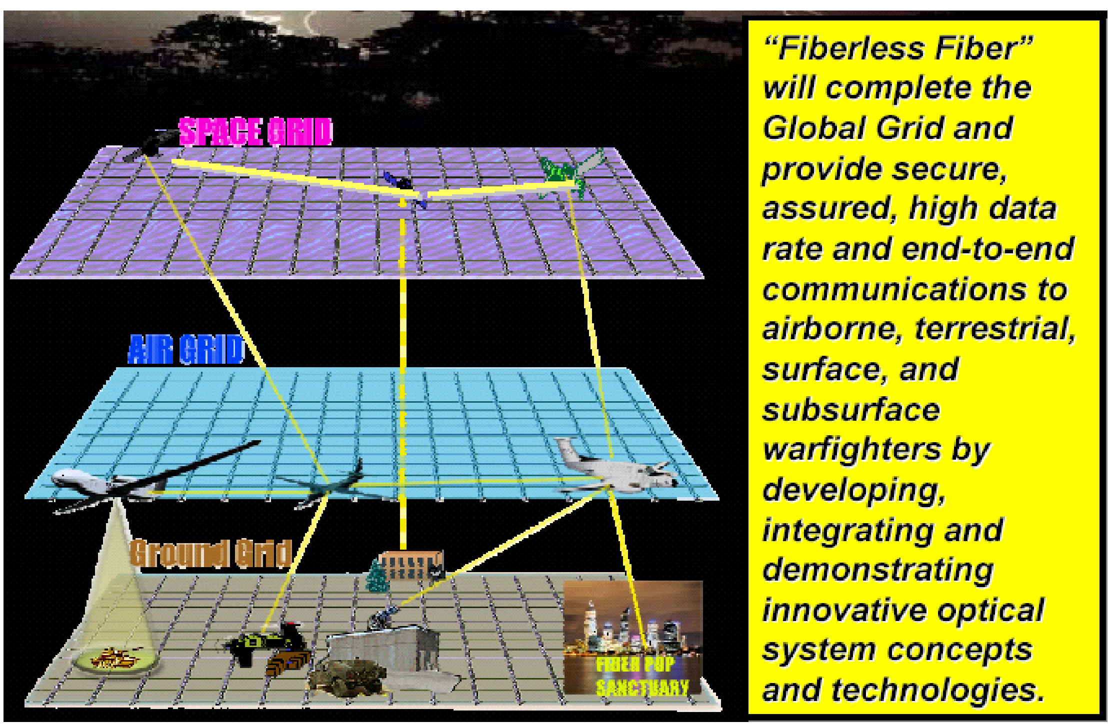


Figure 1-5 Artist Concept of THOR

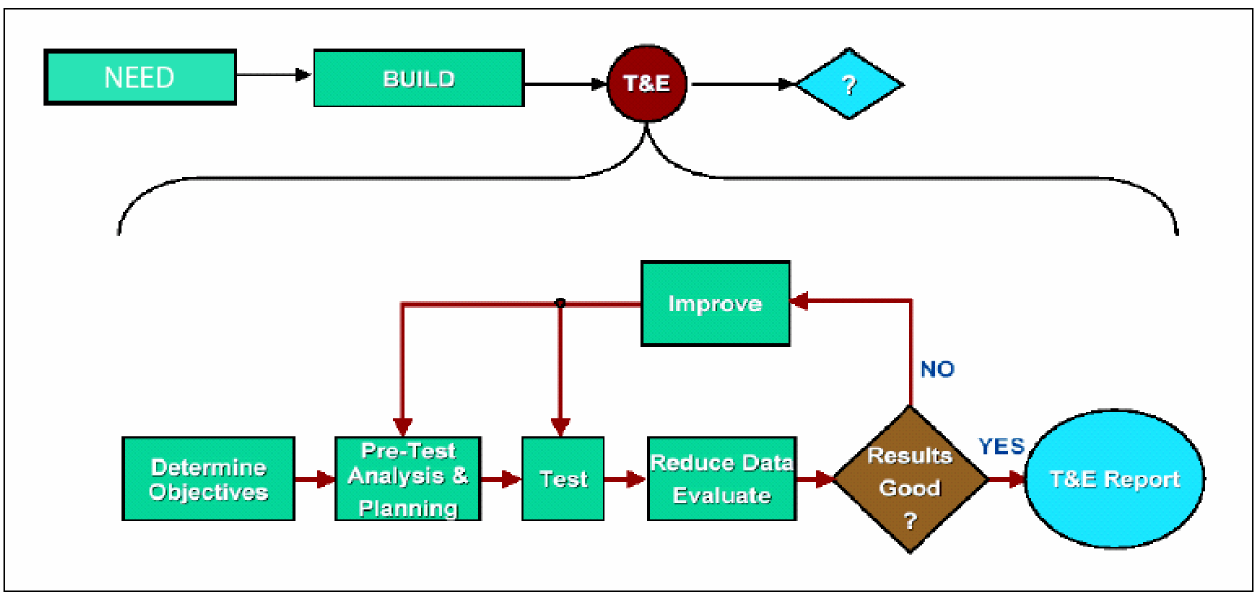
Communications systems based on DE, specifically lasers, may provide the solution to the military's growing problem concerning the availability of bandwidth needed to support an increasingly network-centric, information-dependent force structure. In general, laser-based communications can provide high capacity, reliable, and secure communications between widely distributed, mobile military platforms.

As part of its mission, the AFFTC conducts test and evaluation programs for the Air Force in addition to supporting other test and evaluation customers including the U.S. Army and U.S. Navy. The majority of the work consists of testing total weapons systems, including all major subsystems, as part of the Air Force Mobility Command systems development and support. Each subsystem is evaluated to determine whether it will perform as designed, whether it will perform in conjunction with other subsystems in a mission environment, and the effects on the total system performance.

1.3.2 Developmental Test and Evaluation Process

1.3.2.1 Test and Evaluation Process

Figure 1-6 shows the relationship between system development and the test and evaluation process.



Source: Directed Energy Professional Society 2003.

Figure 1-6 System Development and Test and Evaluation Process

The following steps are integral to the system development phase:

System Development

1. Identify need for developmental system.
2. Build developmental system.

Test and Evaluation Process

1. Determine objectives.
2. Pre-test analysis and planning.
3. Test.
4. Reduce data and evaluate.
5. Check results per objectives and test plan.
6. If satisfactory, complete test and evaluation report.
7. If results are not satisfactory, improvement is required. The problem could be associated with poor pre-test analysis and planning or poor testing/data collection. Rework as necessary and retest as required to meet established test and evaluation objectives.

1.3.2.2 Establish Baseline Measurements

Testing developmental laser systems to develop baseline measurements is necessary to understand characteristics of system hardware in relation to the aircraft that would use the systems. Demonstrating the potential utility and functionality of these systems under field conditions is another step that is required before a decision to go into full-scale production can be made.

1.4 PURPOSE OF THE PROPOSED ACTION

The purpose of the Proposed Action is to conduct test and evaluation of the complex laser aircraft/weapons systems of the future at the AFFTC. The mission of the AFFTC has developed from a high performance aircraft flight test facility in the 1950s and 1960s to that of a high technology test and evaluation center for complete aircraft/avionics systems. Thus, laser testing is a continuation of the evolving primary mission of the AFFTC and is fully in accord with that mission as it has advanced since the 1940s.

An aircraft weapons system today is a tightly integrated system of airframe, engine, avionics (sensors and communications systems), and weapons. As current weapons become integral to the avionics and sensor suite of the aircraft, it becomes impractical to test any part of the system (aircraft, avionics, or weapon) individually.

As laser systems (communications and weapons systems) continue to mature, they will also become an integral part of the complete aircraft system. As the primary Air Force test center for new aircraft and modifications of existing aircraft, it will be necessary to test the laser components of new aircraft of the future along with all the other components of the aircraft system. It is impractical to conduct a thorough test of the airframe, the engine, or any of the avionics suite without being able to operate the laser system as well.

The ABL of today is an example of the early stages of this test and evaluation process. The ABL would continue to be tested and evaluated using the chemical oxygen iodine laser (COIL), which is primarily associated with the aircraft as a large piece of cargo. The COIL exhibits some integration with the aircraft communications and avionics suite and has some impact on the aerodynamic characteristics of the aircraft, but by and large it is a weapon that is carried by the aircraft. Even with the ABL, the airframe/engine must be tested along with the laser to ensure there is no interference between their individual functions. Laser equipped aircraft of the future will likely become so tightly integrated that the flight controls, the aircraft sensor suite, and all pilot/cockpit interfaces will be tested in concert.

Thus, to continue providing the Air Force with a highly capable aircraft and aircraft weapons systems test and evaluation capability, it is essential that the AFFTC conduct test and evaluation of laser systems.

These systems could be similar in design to the ABL, ATL, or THOR laser systems. The test and evaluation of laser systems could utilize facilities at Edwards AFB including but not limited to the Birk Flight Test Facility (BFTF), the Precision Impact Range Area (PIRA), Air Force Research Laboratory (AFRL), portions of Rogers Dry lakebed, and other base facilities and the R-2508 Complex. The objectives of conducting test and evaluation of laser systems include, but are not limited to, the following.

Determine Hardware Characteristics:

- Packaging of laser systems: a function of size and weight constraints;
- Developing an adaptable focusing lens;
- Laser systems with continuous wavelength capability;
- Temperature and pressure constraints;
- Treat and dispose of residual energy buildup;
- System utility in all-weather conditions;
- Developing failsafe software during lasing to meet real-time conditions; and
- Adaptable hardware for field military use.

Determine Beam Characteristics:

- Target acquisition and image enhancement in all weather conditions;
- Evaluate beam properties including reflection off target surfaces;
- Characterize wavelengths adaptable to all weather conditions;
- Long-range calibration of laser systems using satellites, planets, or stars; and
- Refine laser communication capability through free space.

Evaluate System and Mission Performance

- Test acquisition, tracking, and pointing subsystems;
- Investigate system and platform integration issues;
- Evaluate target effects; and

- Perform thermal, power, and radio frequency interference system budget analysis and characterization.

The Proposed Action is being developed to support the Air Force goal of meeting future requirements that are considered necessary for the defense of the territorial United States. This document serves as a programmatic assessment of the environmental affects and any mitigation that may be required to test and evaluate a variety of laser technologies at Edwards AFB and the R-2508 Complex.

1.5 NEED FOR THE PROPOSED ACTION

The proposed action is needed to develop the capability to operate lasers in conjunction with current and future DoD aircraft and to accomplish the AFFTC mission. The AFFTC mission is to "conduct and support research, development, test and evaluation of aerospace systems from concept to combat" (Bedke 2005).

Additionally, to support the requirements of the *Air Force Transformational Flight Plan* published in November 2003, the AFFTC needs to conduct test and evaluation of developmental laser systems to demonstrate critical technologies in a realistic environment.

1.6 ENVIRONMENTAL IMPACT ANALYSIS PROCESS

The NEPA established a national policy to protect the environment and ensure that federal agencies consider the environmental effects of actions in their decision-making. The Council on Environmental Quality is authorized to oversee and recommend national policies to improve the quality of the environment. The Council published regulations that describe how NEPA should be implemented. These regulations encourage federal agencies to develop and implement procedures that address the NEPA process in order to avoid or minimize adverse effects on the environment. Title 32 CFR Part 989 addresses implementation of NEPA as part of the Air Force planning and decision-making process.

1.7 FUTURE USE OF THIS DOCUMENT

Future proposed projects would be reviewed and evaluated to determine if they fall within the scope of this EA. These projects may use the analysis presented in this document if it is determined they fall within the scope of this EA. In some cases, a supplement to this EA may be required. If a supplemental EA is required, a new Finding of No Significant Impact (FONSI) will be necessary. Future actions that are found to result in significant, unmitigable impact on the environment would need to be addressed in an environmental impact statement.

1.8 STRUCTURE OF THIS EA

This EA analyzes and describes the potential environmental impacts that could result from the Proposed Action and Alternatives. As appropriate, the affected environmental consequences of the actions are presented in terms of regional and site-specific descriptions.

Section 2.0 of this EA describes the Proposed Action, Alternatives, and No-Action Alternative. In addition to providing project information, this section describes the general parameters associated with the Proposed Action.

Section 3.0 provides regional and site-specific information related to air quality, airspace, cultural resources, environmental justice and the protection of children, geology and soils, hazardous materials/waste, infrastructure, land use and visual/aesthetic resources, natural resources, noise, safety and occupational health, socioeconomics, and water quality. The regional information included in this section provides the background for understanding the context of the site-specific information that could affect or be affected by the Proposed Action.

Section 4.0 addresses the potential effects of the Proposed Action on the resource areas analyzed. Possible impacts of project activities are analyzed, the significance of each impact is identified in each resource area, and mitigation measures, if required, are so stated.

Sections 5.0 through 8.0 identify, respectively, report references, persons and agencies contacted, preparers, and acronyms and abbreviations used in this EA.

Appendix A contains a copy of the air emissions analysis conducted for the proposed project. Appendix B is an analysis of laser energy at test ranges that was extracted from the *Final Environmental Impact Statement for the Program Definition and Risk Reduction Phase of the Airborne Laser Program* (U.S. Air Force 1997). The distribution list for this EA is included in Appendix C. Appendix D shows photos of the proposed target areas. Responses to public/agency comments received are provided in Appendix E.

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2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.1 INTRODUCTION

This section describes the Proposed Action and Alternatives, including the No-Action Alternative. The potential environmental impacts for each alternative are summarized in table form at the end of this chapter. Target areas located only on Edwards AFB would be limited to 5 acres per site, with a maximum of 100 acres total for the designated sites and future undesignated sites. Photos of the proposed target sites are shown in Appendix D. Alternative A, the Proposed Action Alternative, is to conduct low, medium, and high power laser testing within Region 1 and Region 2 in the ground-to-ground (G/G), ground-to-air (G/A), air-to-ground (A/G), and air-to-air (A/A) modes. Region 1 is defined as Edwards AFB (Management Areas A through G) and the airspace in restricted area R-2515, and Region 2 is the airspace within the R-2508 Complex. Communications lasers, in addition to being tested in the G/G, G/A, A/G, and A/A modes, would be tested at low, medium, and high power settings in ground-to-space (G/S), space-to-ground (S/G), air-to-space (A/S), and space-to-air (S/A) modes.

Under Alternative B only low power laser testing would occur within Region 1 and Region 2 for the G/G, G/A, A/G, and A/A modes, and medium and high power laser testing would occur inside test facilities and controlled areas at Edwards AFB. Controlled areas would include designated target boards and other targets on Edwards AFB that meet specific safety requirements and for which there is a completed preliminary hazards assessment and an approved Air Force (AF) Form 813/332. Communication lasers would be tested in A/G, G/A, G/S, S/G, A/S, and S/A modes at low power setting in Region 2 and medium and high power settings inside test facilities and controlled areas of Edwards AFB.

Under Alternative C, the No-Action Alternative, laser testing would continue based on the *ABL Final Environmental Impact Statement for the Program Definition and Risk Reduction Phase of the Air Base Laser* (U.S. Air Force 1997) and *Supplemental Environmental Impact Statement for the Airborne Laser Program* (Air Force Center for Environmental Excellence [AFCEE] 2003); low power lasing of G/G targets would be limited to Management Area B in the PIRA.

2.2 ALTERNATIVE IDENTIFICATION PROCESS

The analysis of the Proposed Action and Alternatives is the cornerstone of the EA. It is intended to provide the decision maker and the public with a clear understanding of the relevant issues and the basis of the choice among identified options. The alternatives must fulfill the need and purpose of the Proposed Action and be consistent with the goals, policies, management strategy, and mission requirements of the AFFTC.

The criteria identified here establish a minimum set of requirements that must be met in order for an alternative to be considered viable. Those alternatives not meeting one or more of the selection criteria have been eliminated from further discussion. The reason(s) why each was eliminated is/are documented in Section 2.4.4. Alternatives meeting all selection criteria are retained and each is fully analyzed in Chapter 4 (Environmental Consequences) of this EA.

The criteria used to select the alternatives discussed in this document are described below. They address the need to test complete weapon system performance at the AFFTC when the test requires the operation of a high-energy laser (HEL) system. A viable alternative would:

- Present a broad range of airspace and ground test areas for operation of the test aircraft, its applicable subsystems, and the HEL system under test;
- Allow full functioning of the HEL system for complete system evaluation;
- Provide a full range of instrumentation and data reduction capability;
- Include a wide range of targets and target areas for evaluation of HEL system effectiveness;
- Support operations of all aircraft subsystems required to integrate with the HEL, e.g. electrical, hydraulic, avionics, engines, flight controls;
- Permit operation of both the aircraft and the HEL system without restrictions that would invalidate test results; and
- Provide an acceptable safety environment including necessary containment of HEL energy.

2.3 PROJECT BACKGROUND INFORMATION

A laser is a device that produces a beam of light that is monochromatic (one specific wavelength), spatially coherent, and highly directional. At low power, lasers provide reliable communications; at high power they damage or destroy targets at long range. An example of a basic laser is shown in Figure 2-1.

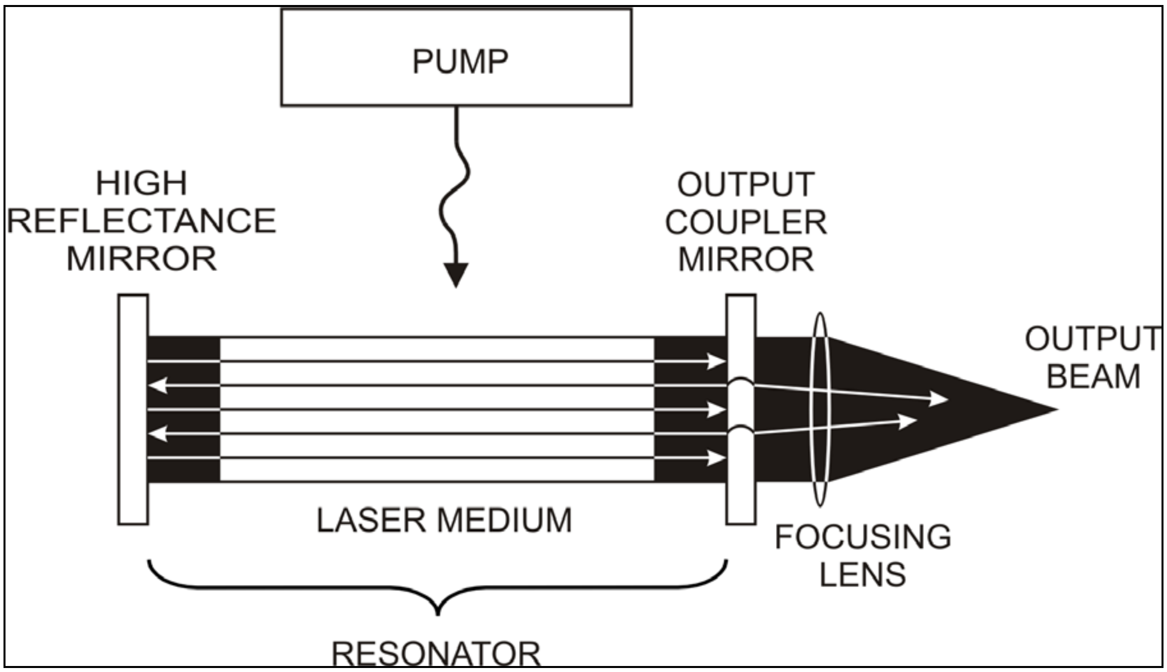


Figure 2-1 Basic Laser

2.3.1 Laser Classification

The American National Standards Institute (ANSI) Z136.1 (ANSI 2000a) designates lasers by the following classes:

- Class 1. This class denotes lasers that are not hazardous for continuous viewing or are designed in such a way that prevents human access to laser radiation. These consist of low power lasers or high power embedded lasers (e.g., laser printers, compact disc players).

- Class 2. This class denotes low-power visible lasers or laser systems, which because of the normal human bright light aversion (i.e., blinking, eye movement), do not normally present a hazard, but may present some potential for hazard if viewed directly for extended periods of time (like many conventional light sources). (1 milliwatt [mW])

- Class 3a. This subclass denotes lasers or laser systems that normally would not injure the eye if viewed for only momentary periods (within the aversion response period) with the unaided eye, but a hazard may be present if viewed using collected optics. (5 mW)

- Class 3b. This subclass denotes lasers or laser systems that can produce a hazard if viewed directly, including intra-beam viewing of specular reflections. Normally, Class 3b lasers will not produce a hazardous diffuse reflection from a matte target. (500 mW)

- Class 4. This class denotes lasers or laser systems that produce a hazard not only from direct or specular reflections, but may also produce hazardous diffuse reflections. Such lasers may produce significant skin hazards as well as fire hazards.

2.3.2 Laser Categories

Lasers can be categorized and described by several different characteristics. These include:

- Lasing Medium (gas [carbon dioxide, argon-ion, Excimer] [similar to LASIK laser used for eye surgery], solid [neodymium: yttrium aluminum garnet (Nd:YAG), yttrium lithium fluoride (YLF), titanium-sapphire], semiconductor [gallium arsenide], or dye);

- Mode of Operation (continuous wave, pulsed [<0.25 seconds], or Q-switched);

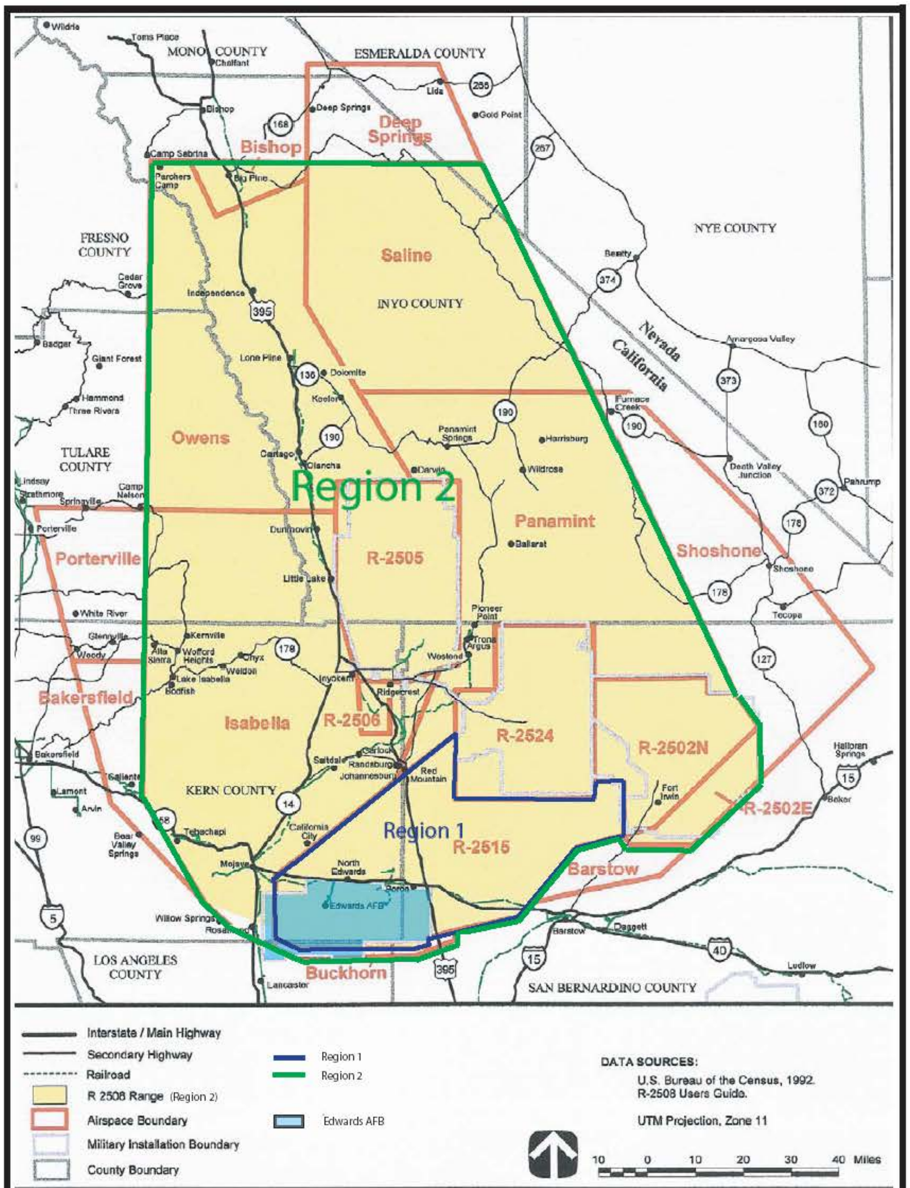
- Wavelength (ultraviolet [UV]: UV-A [315–400 micrometers (μm)], UV-B [280–315 μm], UV-C [100–280 μm]; visible to near infrared [IR]: visible [400–700 μm], IR-A [700–1,400 μm]; mid to far IR: IR-B [1,400–3,000 μm], or IR-C [3,000–10,600 μm]); and

- Power:
    - — Low Power. Output is 0 to 10 watts (W)
    - — Medium Power. Output is 10 W to 1 kilowatt (kW); and
    - — High Power. Output exceeds 1 kW.

For the purposes of this EA, laser systems will be categorized by power.

2.4 DESCRIPTION OF THE ALTERNATIVES

The location for the Proposed Action and Alternatives is within the R-2508 Complex (Figure 2-2).



Test Areas for the Proposed Action and Alternatives | Figure 2-2 | Q242-04 | 1/06/05

Figure 2-2 Test Areas for the Proposed Action and Alternatives

Detailed descriptions of the airspace and land use for the proposed operating area are provided in Sections 3.2 and 3.8, respectively. Laser test and evaluation events would be scheduled to occur in Region 1 at Edwards AFB (Figure 2-3) and Region 2 (Figure 2-2) based on the requirements listed in the test plan, test schedule and operational regulations, and safety standards. Table 2-1 lists the projected/estimated maximum flights that would be conducted under this program. Table 2-2 lists the projected/estimated G/G missions that would be conducted under this program.

Table 2-1

Projected/Estimated Laser Test and Evaluation Flights

Year	Number of Flights[1]	Year	Number of Flights[1]
2006	140	2009	394
2007	163	2010	394
2008	327		

Notes: 1 – Number of flights includes laser test and evaluation aircraft, chase aircraft, and target aircraft.

Source: Montoya 2005.

Table 2-2

Projected/Estimated Laser Test and Evaluation Ground-to-Ground Missions

Year	Number of Missions
2006	24
2007	24
2008	24
2009	24
2010	24

Source: Montoya 2005.

Fixed-wing aircraft and helicopters (similar to the B747, AC-130, B1-B, H-47, F-22, MV-22, unmanned aerial vehicle (UAV), and associated chase aircraft [T-38, F-15, or F-16s]) involved in laser test and evaluation in A/G, G/A, and A/A modes would launch from Runway 22 at Edwards AFB and climb to the appropriate test altitude based on safety and technical requirements. Airborne targets like the Proteus aircraft for A/A and G/A testing would also climb to the appropriate test altitude based on safety and technical requirements. Ground targets for the G/A testing would be protected by earthen berms, rock outcrops, or enclosures to control the reflected laser energy, or they would be located in controlled areas with an established and approved laser hazard zone and laser surface danger zone.

2.4.1 Alternative A (Desired Capability, Proposed Action Alternative)

Alternative A, the Proposed Action Alternative, is to conduct low, medium, and high power laser testing within Region 1 and Region 2 in the G/G, G/A, A/G, and A/A modes. Target boards and other approved ground targets used for G/G or A/G modes would be located on Edwards AFB, with most targets and target boards located in Management Area B (PIRA) and Management Area G (AFRL). Airborne targets like the Proteus aircraft or other airborne platforms used as targets would remain in the military controlled restricted area R-2515 (in Region 1) and lasing activity would occur over Edwards AFB. The aircraft firing the laser towards A/A or A/G targets could be at other locations within Region 2. Communication lasers would be tested in the low, medium, and high power setting for A/G, G/A, G/S, S/G, A/S, and S/A modes in the areas shown on Figure 2-2. Figure 2-2 shows the special use airspace (SUA) where the proposed testing would occur. The areas outlined in red are the military operating areas; the restricted use airspace such as R-2502, R-2505, R-2506, R-2515, and R-2524 is outlined in gray.

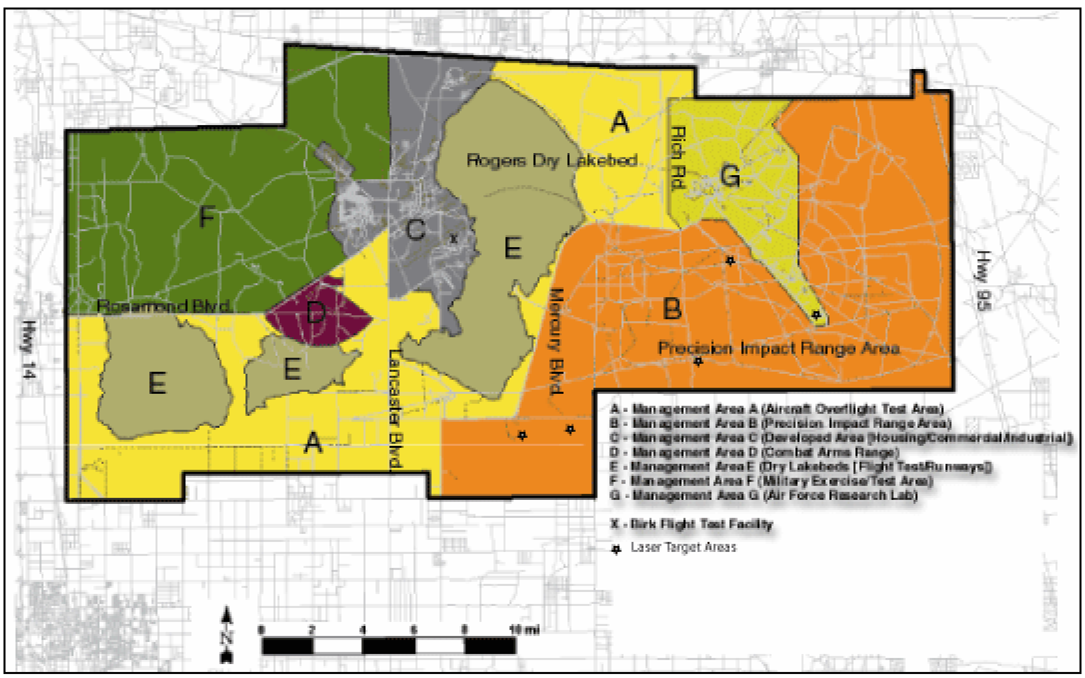


Figure 2-3 Edwards AFB Management Areas

Edwards AFB, shown in blue on Figure 2-2, is subdivided into management areas A through G (Figure 2-3). New targets could be placed in other controlled areas after analysis of the target area and after the test and safety plans verified that no significant, unmitigable impacts would occur as a result of using the new target area. Ground target areas would only be located on Edwards AFB and would be limited to 5 acres per site, with a maximum of 100 acres total for the designated sites and future undesignated sites.

Developmental systems using next generation laser technologies are being tested and evaluated to determine their adaptability and suitability to military missions. Developmental systems are those systems that have gone from concept model to the developmental phase and require a period of further testing and evaluation before production is justified. Next generation developmental systems may require testing and evaluation of variants to current systems like the COIL, solid state lasers, or other laser technologies. If hazardous laser energy were to be released outside the controlled airspace of the test range, atmospheric lasing events could require clearance from the U.S. Space Command (Laser Clearing House) and the regional Federal Aviation Administration (FAA). The laser parameters (wavelength, power, beam divergence, and vector [e.g., above the horizon]) are the factors considered by these agencies when determining if approval for the lasing event will be granted.

Developmental systems would be investigated as part of the proposed program to develop baseline information on beam characteristics and hardware properties. Some of the properties that will be investigated and developed during the testing and evaluation are presented in Table 2-3.

Table 2-3
Candidate Laser System Properties Requiring Test and Evaluation

Beam Properties	Hardware Systems
Refine target acquisition and targeting capability	Refine adaptable optical focusing lens for differing target requirements
Calibrate target distances with software systems	Refine laser systems that are transportable and functional in the field
Refine target image enhancement capability	Refine software command and control systems with laser operations
Refine the 1.315 micrometer (μm) wavelength or variant forms to scalable power levels to the 1 megawatt (MW) class	Develop system with scalable wavelength to generate power to the 1 MW class

Table 2-3, Page 1 of 2

Table 2-3 (Continued)

Candidate Laser System Properties Requiring Test and Evaluation

Beam Properties	Hardware Systems
Characterize wavelet properties over a variety of distances (e.g., dispersion, distortion, wiggle)	Refine disposal mechanisms for generated hazardous waste
Refine wavelet frequencies to deliver maximum power to target	Develop failsafe software during lasing and calibration software package to meet real-time field conditions
Develop laser beam for all weather conditions	Refine disposal system for pressure and/or residual energy buildup during lasing events
Refine beam for communication networks through free-space propagation and broadband efficiencies	Refine precision strike capability from ground or air
Determine reflective potential of various target surfaces	Refine countermeasure system against missiles

Table 2-3, Page 2 of 2

Adaptation of these laser systems to a war-fighting capability would be further investigated to determine field applicability. Developmental systems that may be tested and evaluated in variant forms at Edwards AFB may include:

- Anti-aircraft missile countermeasures;
- Airborne tactical precision strike of ground targets;
- Airborne tactical strike of airborne targets;
- Precision strike using ground-based laser and relay mirrors in space;
- Cruise missile countermeasures; and
- Broadband technology in communication networking.

2.4.1.1 Ground Test Activities

Lasers would be directed at laser target areas (LTAs) and each firing position (FP) or any new LTA (including additional LTAs and FPs at AFRL) would be evaluated by the 95th Air Base Wing, Environmental Management Division (ABW/CEV) and permitted by the Range Safety Office and Range Control Office before the lasing event or activity occurred. Each FP would have specific requirements regarding beam divergence angles to each target site. The beam divergence angle is defined as the amount of spread that light emits from its laser source to the target and is measured in milliradians (mrad).

The beam divergence angle is a factor in determining the laser surface danger zone (LSDZ), a calculated area where light radiation levels may exceed the maximum permissible exposure (MPE). The MPE is the level at which a person may be exposed without harmful effect and with an acceptable degree of safety.

Ground testing of developmental laser systems would be conducted in established laser testing facilities and from ground stations and human-transportable and/or robotic ground vehicles located in positions on Edwards AFB as determined by the test plan. Lasers would be directed over open land to ground targets with backdrops. Targets would be located in areas of topographic relief so that rock outcrops and elevated terrain could be used as backdrops. Target sites located near the dry lakebeds would have earthen berms as backdrops. Examples of proposed target locations include Grinnel, Mt. Mesa, Jackrabbit Hill, and Haystack Butte (Figure 2-4). Additional LTAs or targets would also be assessed using environmental management and bioenvironmental engineering criteria to assure minimal risk to human health and biological, cultural, and other resource areas.

Ground testing activities could include the following:

- Laser systems servicing that would be accomplished according to manufacturer and test plan requirements.

- Construction and placement of target boards made of materials designed to minimize specular reflection and mounted with an array of sensors and telemetry instruments. Target boards could be stationary or mounted on vehicles.

- Testing developmental laser systems in the G/G, G/A, and A/G modes as applicable to the particular system. Testing space-based laser systems in the G/S, S/G, and A/S modes would focus on communications-related systems.

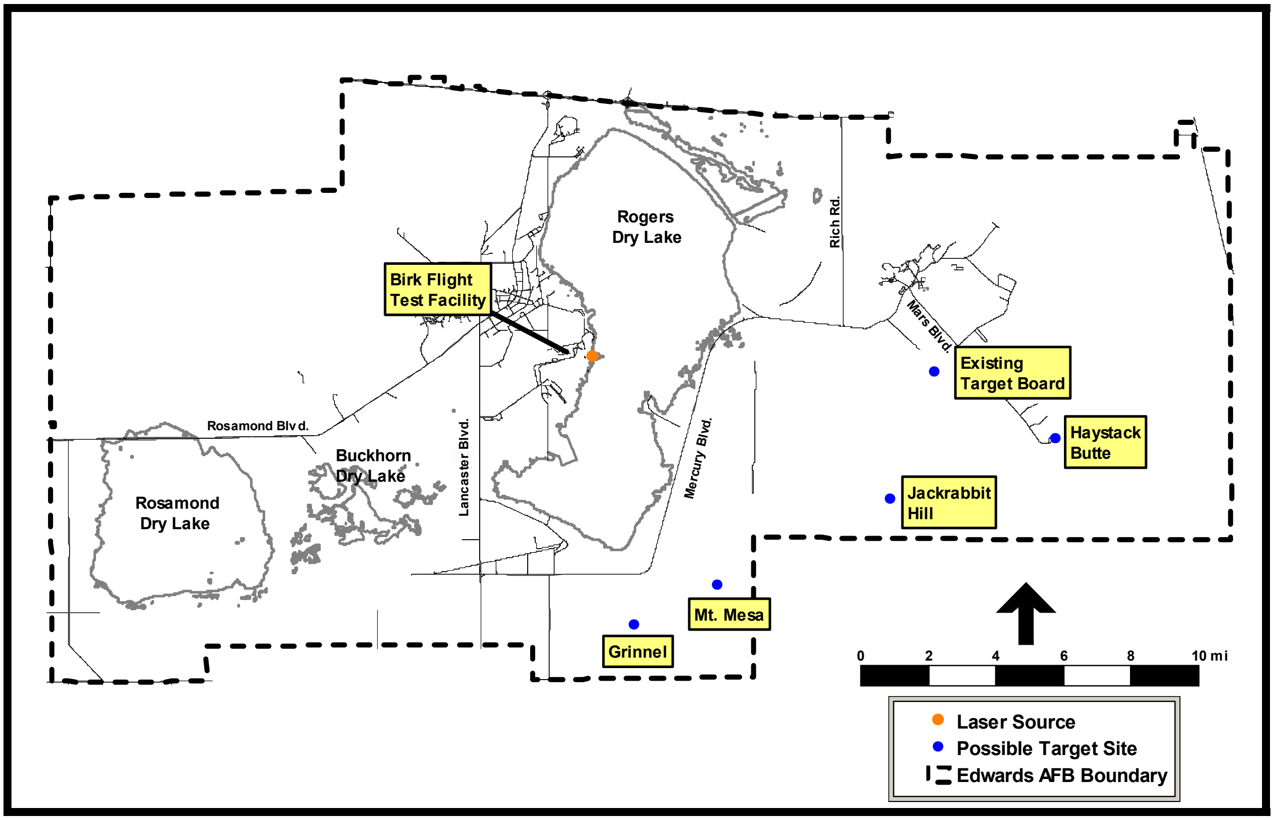


Figure 2-4 Examples of Laser Target Areas

- Simulating long-distance targeting capability;
- Developing and testing laser countermeasures;
- Characterizing the acquisition, tracking, and pointing subsystems;
- Developing and evaluating operational system software for command and control; and/or
- Refining broadband communication.

2.4.1.2 Flight Test Activities

Aircraft-mounted developmental laser systems that lase targets on any of the Edwards AFB Management Areas would require permitting for testing as authorized by the 95 ABW/CEV Environmental Management (EM), Bioenvironmental Engineering, Range Control, and Range Safety Offices. Each laser system's LSDZ would be calculated and approved by the Range Control Office prior to all lasing. The

LSDZ is a function of altitude above ground level, angle of approach to target, and the laser system specific buffer angle. The buffer angle is the angle created by the laser line of sight (LOS) from the laser aperture to the target; it is used to define the buffer zone, a conical area from the laser aperture to the target in which the laser beam is confined. The divergent effects of the laser beam vary with the target site and are a function of altitude and angle of approach. For all laser systems, the amount of area enveloped by the laser is based on the buffer angle and defines the LSDZs. Due to land use constraints based on biological resources and knowledge of the buffer angle, the LSDZ for each system is critical in allowing laser systems to be tested on any of the pre-designated A/G targets on the Management Areas at Edwards AFB.

Lasing performed in the air would be used to evaluate beam precision, focusing, imaging, and target ranging for the developmental laser systems or their surrogates, as described in the approved test plan. Calibrations of system software packages to laser beam control and command would also be tested and evaluated. Flight test activities could include the following:

- In-flight servicing of laser systems accomplished according to manufacturer and test plan requirements.
- Construction of target boards with an array of sensors and telemetry instruments. Target boards could be mounted on simulated air platforms or designated air targets designed to minimize specular reflection.
- Testing developmental laser systems in the A/A and A/G modes as applicable to the particular system. Testing of space-based laser systems in the G/S, S/G, A/S, and S/A modes would be used for communications-related systems.
- Simulation of long-distance targeting capability.
- Development and testing of laser countermeasures.
- Developing and evaluating operational system software for command and control.
- Refining broadband communication.

2.4.2 Alternative B (Limited Capability)

Alternative B would be similar to Alternative A, except only low power laser testing would be conducted in Region 1 and Region 2 for the G/G, G/A, A/G, A/A modes. Medium and high power laser testing would be conducted inside test facilities and controlled areas on Edwards AFB (see Figure 2-3).

Target boards and other approved ground targets used for G/G or A/G modes would be located on Edwards AFB. Airborne targets would be located within restricted area R-2515 airspace over Edwards AFB; however, the aircraft firing the laser towards A/A or A/G targets could be at other locations within Region 1 or Region 2. Communication lasers would be tested in the low power setting for A/G, G/A, G/S, S/G, A/S, and S/A modes in Region 2 and medium and high power settings inside test facilities and controlled areas of Edwards AFB.

2.4.3 Alternative C (No-Action Alternative)

Alternative C (No-Action Alternative) is the status quo with low power lasing of G/G targets limited to Management Area B. Flight tests of the ABL using A/A targets would be performed within the R-2508 Complex (Region 2).

Developmental laser systems like the ABL would continue to be tested and evaluated using the COIL as the power source. Laser simulations of the COIL would be tested in pressure chambers at the BFTF prior to integration into the ABL system. The 1.315 µm wavelength generated by the COIL would continue to be evaluated to determine beam characteristics and ultimate power levels. The ABL systems would be ground tested by lasing to targets in the PIRA to calibrate the various laser systems with command and control software packages. Flight tests of the ABL system would be performed in the R-2508 Complex to test imaging and ranging capabilities against target boards attached to aircraft. Test and evaluation programs would use existing facilities, and buildings would be modified on an as-needed basis. The existing workforce would be sufficient to complete the program as planned; however, the workforce could increase if the magnitude and complexity of the testing programs changed.

2.4.4 Alternatives Eliminated From Further Consideration

The Council on Environmental Quality regulations require that NEPA documents evaluate all reasonable alternatives, briefly discuss those alternatives eliminated from detailed analysis, and provide the reasons for elimination of any alternatives (40 CFR 1502.14(a)). “Reasonable is defined as practical or feasible from a common sense, technical, and economic standpoint." (51 *Federal Register* [FR] 15618, April 25, 1986).

2.4.4.1 Long-Range Testing of High-Power Lasers Fired From Areas Off the California Coast

Testing of high-power lasers fired from the warning areas off the coast of California was briefly considered but eliminated from consideration because of the potential constraints and impacts to population areas between firing positions and target sites.

2.4.4.2 Long-Range Testing of High-Power Lasers Fired From the R-2508 Complex to Targets off the California Coast

The testing of high-power lasers fired from the R-2508 Complex to targets off the coast of California was also briefly considered but eliminated from consideration because of the potential constraints and impacts to population areas between firing positions and target sites.

2.5 ISSUES AND CONCERNS CONSIDERED

During the scoping process, the following issues and concerns were identified as requiring assessment when considering the potential environmental impacts of the alternatives.

- Air Quality. Air pollutant emissions generated from aerospace ground equipment (AGE) and vehicle miles traveled in support of laser field operations during ground and airborne test and evaluation would be similar to the ABL program. Emissions would not exceed *de minimis* levels (AFCEE 2003). Emissions from the Ground Pressure Recovery Assembly (GPRA) during ground-based testing would pass through a scrubber to reduce 95 percent of exhaust emissions. The effects of chemicals dumped during flight testing will be evaluated.

- Airspace Management. Atmospheric lasing activities would be performed within the R-2508 Complex upward into the atmosphere toward infinity and would have no environmental effects. Lasing in the atmosphere at target boards attached to aircraft is described in the ABL Final Environmental Impact Statement (AFCEE 2003). Lasing at ground targets in the A/G and S/G modes—and the associated specular reflections—could result in minor environmental effects if surveillance areas have not been established.

- Cultural Resources. Cultural resources could be impacted during the clearing of new target sites in the PIRA, in areas along the dry lakebed, or during the siting of new facilities.

- Geology and Soils. The heat created by the laser beam coming in contact with the soils or rock surfaces could result in spalling, melting, and fusing of surface features.

- Hazardous Materials and Waste. Laser systems using variant forms of chemical and solid state lasers would use hazardous materials in the laser resonator and laser gain medium that may generate hazardous waste.

- Infrastructure. Testing and evaluation of next generation laser systems may require renovation of and additions to existing facilities and utility systems. The addition of support personnel would also affect traffic flow on-base during program activities. Installation of energy efficient systems would be part of the conservation measures to reduce energy consumption and operating costs.

- Land Use. Lasers could be directed at targets in the PIRA, sites in portions of the Rogers Dry lakebed, sites at AFRL, and other Management Areas as identified in test plans approved by the Test System Safety Officer and Range Control Office. Laser targets would be located in designated areas approved by EM. Developmental laser systems may require that additional target sites be established in the PIRA and other Management Areas during G/G, A/G, and S/G tests. These sites would require environmental compliance review prior to designation as LTAs or FPs.

- Natural Resources. Potential impacts to natural habitat may result during the setting up of new target sites or during lasing to target sites. Potential direct impacts to wildlife may include impacts on the desert tortoise (federal and state listed as threatened) and Mohave ground squirrel (state listed threatened) and the plant communities that support these species. Critical habitats could also be affected by laser testing.

- Noise. Potential impacts due to the additional personnel, traffic, and ground and flight activities will be assessed.

- Safety and Occupational Health. Laser systems directed at targets could result in spurious reflection patterns from reflective surfaces and soil cover that could result in ocular health risks or fire hazard. Low power lasers that cannot cause eye damage without optical magnification are not subject to this assessment.

- Socioeconomics. An increase in support personnel during program activities would affect services and the economy on the Base and in the surrounding community.

- Water Resources. If not properly managed the chemicals associated with lasing activities could be released into the water systems and have an effect on water quality and water resources.

2.6 ISSUES AND CONCERNS DISCUSSED BUT NOT CONSIDERED RELEVANT FOR FURTHER ANALYSIS

The following issues and concerns were initially considered, but subsequently eliminated from analysis in this EA. Consequently, they will only be briefly addressed in Chapters 3 and 4.

- Environmental Justice and Protection of Children. The Executive Orders (EOs) on Environmental Justice and the protection of children require federal agencies to identify and address disproportionately high adverse effects of their activities on minority and low-income populations and children. The proposed activities discussed in this EA were reviewed against EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, and EO 13045, *Protection of Children from Environmental Health and Safety Risks*. Given that the renovation/construction activities would occur entirely on Edwards AFB, the U.S. Air Force has determined that this action would have no substantial, disproportionate impacts on minority and low-income populations and/or children.

- Public/Emergency Services. The operating areas and targets selected for this Proposed Action are within the footprint of Edwards AFB for all ground-based activities; flight-related tests would be restricted to the R-2508 Complex. Access is restricted to personnel having a specific need to be on the base, thus limiting the general access to areas where testing would occur. Test plans approved by the Test System Safety Officer and Range Control Office would further limit access to test and evaluation operating areas.

Provisions for public and emergency services are established for the base and the communities within the R-2508 Complex as necessary to meet the needs of the AFFTC mission; therefore, this action would have no substantial impact on public/emergency services.

2.7 OTHER FUTURE ACTIONS IN THE REGION

Other actions within the region were evaluated to determine whether cumulative environmental impacts could result from implementation of the Proposed Action and Alternatives. Cumulative impacts result from “the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time” (40 CFR 1508.7).

Other actions within the geographic region of Edwards AFB and the R-2508/R-2515 special use airspace that could be considered to have the potential for cumulative effects include other flight test programs. However, because appropriate range safety requirements are in place to ensure a safe environment to conduct flight tests, along with coordination with the FAA, these actions are not expected to have cumulative impacts.

2.8 COMPARISON OF ENVIRONMENTAL IMPACTS

Table 2-4 presents a summary of anticipated environmental impacts for each alternative.

Table 2-4

Anticipated Environmental Impacts for the Affected Environment

Issue	Alternative A	Alternative B	Alternative C
Air Quality	Minimal	Minimal	Minimal
Airspace	Minor	Minor	None
Cultural Resources	Minimal	None	None
Geology and Soils	Minimal	Minimal	Minimal
Environmental Justice and the Protection of Children	None	None	None
Hazardous Waste/Hazardous Materials	Minimal	Minimal	Minimal
Infrastructure	Minimal	Minimal	Minimal
Land Use	Minor	Minor	Minor
Natural Resources	Minor	Minor	Minor
Noise	Minimal	Minimal	Minimal
Public/Emergency Services	None	None	None
Safety	Minor	Minor	Minor
Socioeconomics	Minimal	Minimal	None
Water Resources	Minimal	Minimal	None

Notes: None: There are no impacts expected.

Minimal: The impacts are not expected to be measurable, or are measurable but are within the capacity of the impacted system to absorb the change, or the impacts can be compensated for with little effort and resources so the impact is not substantial.

Minor: The impacts are measurable, but are within the capacity of the impacted system to absorb the change, or the impacts can be compensated for with little effort and resources so the impact is not substantial.

Moderate: Potentially adverse impacts that are measurable, but do not violate any laws or regulations and are within the capacity of the impacted system to absorb the change, or the impacts can be mitigated with effort and resources so that they are not significant.

Major: Those environmental impacts that individually or cumulatively could be substantial.

3.0 AFFECTED ENVIRONMENT

This chapter describes existing environmental conditions likely to be affected by Alternatives A and B. The Region of Influence (ROI) consists of Edwards AFB, restricted area R-2515, and the R-2508 Complex. The ROI for each action will be discussed in terms of two distinct regions: Region 1 and Region 2. Region 1 comprises Edwards AFB (including Management Areas A through G) and the airspace in restricted area R-2515, and Region 2 comprises the airspace in the R-2508 Complex.

Resources within the ROI have been identified under the following categories: air quality, airspace, cultural resources, *environmental justice and protection of children*, geology and soils, hazardous waste/hazardous materials, infrastructure, energy resources, land use, natural resources, noise, *public/emergency services*, safety and occupational health, socioeconomics, and water resources. Resource categories shown in italics will be briefly covered.

3.1 AIR QUALITY

Air quality in a given location is defined by the concentration of various pollutants in the atmosphere and is typically expressed in parts per million or micrograms per cubic meter. By comparing a pollutant concentration in the atmosphere to federal and/or state ambient air quality standards, the significance of its presence can be determined. These standards represent the maximum allowable atmospheric concentrations that may occur while still protecting public health and welfare with a reasonable margin of safety. The federal standards are established by the U.S. Environmental Protection Agency (U.S. EPA) and are termed the National Ambient Air Quality Standards (NAAQS). The NAAQS are defined as maximum acceptable ground-level concentrations that may not be exceeded more than once per year, with the exception of annual standards that may never be exceeded. These standards include concentrations for ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter 10 microns or less in diameter (PM_{10}), particulate matter 2.5 microns or less in diameter ($PM_{2.5}$), and lead. The California Air Resources Board (CARB) has established state standards termed the California Ambient Air Quality Standards (CAAQS). The CAAQS are at least as restrictive as the NAAQS and include pollutants for which there are no national standards. The national and state ambient air quality standards are shown in Table 3-1.

The pollutants considered in the impact analysis of this EA include volatile organic compounds (VOCs), ozone, CO, NO_2, SO_2, and PM_{10}. Conformity guidelines do not present threshold levels for $PM_{2.5}$ and only known negligible sources of lead are associated with the proposed project; therefore, $PM_{2.5}$ and

Table 3-1

National and California Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards	National Standards(a) Primary(b,c)	National Standards(a) Secondary(b,d)
Ozone	1-hour	0.09 ppm	0.12 ppm	Same as primary
	8-hour	---	0.08 ppm	Same as primary
Carbon monoxide	1-hour	20 ppm	35 ppm (40 mg/m^3)	none
	8-hour	9.0 ppm	9 ppm (10 mg/m^3)	none
Nitrogen dioxide	1-hour	0.25 ppm	---	---
	Annual (arithmetic mean)	---	0.053 ppm (100 μg/m^3)	Same as primary
Sulfur dioxide	1-hour	0.25 ppm	---	---
	3-hour	---	---	0.5 ppm (1,300 μg /m^3)
	24-hour	0.04 ppm	0.14 ppm	---
	Annual (arithmetic mean)	---	0.03 ppm	---
PM_{10}	24-hour	50 μg /m^3	150 μg /m^3	---
	Annual (arithmetic mean)	20 μg /m^3	50 μg /m^3	Same as primary
$PM_{2.5}$	24-hour	---	65 μg /m^3	---
	Annual (arithmetic mean)	12 μg /m^3	15 μg /m^3	Same as primary
Lead	30-day average	1.5 μg /m^3	---	---
	Quarterly average	---	1.5 μg /m^3	Same as primary

Table 3-1, Page 1 of 2

Notes: a – Other than for ozone and those based upon annual averages, standards are not to be exceeded more than once per year. The ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is equal to or less than 1.

b – Concentrations are expressed first in the units in which they were promulgated. Equivalent units are given in parentheses.

c – Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health. Each state must attain the primary standards no later than 3 years after the U.S. EPA approves the state's implementation plan.

d – Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Each state must attain the secondary standards within a "reasonable time" after the U.S. EPA approves the implementation plan.

Table 3-1

National and California Ambient Air Quality Standards (Continued)

Table 3-1, Page 2 of 2

Notes: (Continued)

EPA – Environmental Protection Agency
$\mu g/m^3$ – micrograms per cubic meter
mg/m^3 – milligrams per cubic meter
$PM_{2.5}$ – particulate matter equal to or less than 2.5 microns in diameter
PM_{10} – particulate mater equal to or less than 10 microns in diameter
ppm – parts per million

Source: California Air Resources Board 2003a.

airborne emissions of lead are not considered in this EA. Emission of NO_2 and VOCs are of particular concern, as they are precursors to the formation of ozone.

Ozone concentrations are generally highest during the summer and coincide with the period of maximum insolation, or the maximum amount of solar radiation striking the earth's surface. Maximum ozone concentrations tend to be regionally distributed due to the homogeneous dispersion of precursor emissions in the atmosphere. Concentrations of inert pollutants, such as CO, tend to be the greatest during the cooler months of the year and are often a product of light wind conditions and nighttime/early morning surface-based inversions. Maximum inert pollutant concentrations are usually found near an emission source.

Evaluating impacts to air quality in the ROI requires knowledge of (1) the types of pollutants being emitted, (2) emission rates of the pollutant source, (3) the proximity of project emission sources to other emission sources, (4) topography, and (5) local and regional meteorological conditions. The area of effect for emissions of inert pollutants (pollutants other than ozone and its precursors) is generally limited to a few miles downwind from the source. The area of effect for ozone generally extends much further downwind. In the presence of solar radiation, the maximum effect of precursor emissions on ozone levels usually occurs several hours after their release and, therefore, many miles from the source.

The U.S. EPA designates all areas of the United States as having air quality better than (attainment) or worse than (non-attainment) the NAAQS. The criteria for non-attainment designation vary by pollutant. An area is (1) in non-attainment for ozone if its NAAQS has been exceeded more than three discontinuous times in 3 years at a single monitoring station and an area is (2) in non-attainment for any other pollutant if its NAAQS has been exceeded more than once per year. Pollutants in an area are often designated as unclassified when there are insufficient ambient air quality data for the U.S. EPA to form a basis for attainment status. The CARB considers an area to be in non-attainment of a CAAQS for a particular pollutant if (1) the standards for ozone, CO (except Lake Tahoe), SO_2 (1- and 24-hour), NO_2, PM_{10}, and visibility reducing particles have been exceeded or (2) the standards for the remaining pollutants have been equaled or exceeded.

Air quality regulations were first promulgated with the federal Clean Air Act (CAA). This Act established the NAAQS and delegated the enforcement of air pollution regulations to the states. In areas where the NAAQS are exceeded, the CAA requires preparation of a State Implementation Plan (SIP) that describes how a state will attain the standards within mandated time frames. The CAA Amendments revised the attainment planning process, basing new requirements and compliance dates for reaching attainment upon the severity of the air quality standard violation.

Federal conformity guidelines included in the CAA Amendments state that a federal agency cannot support an activity unless the agency determines that the activity will conform to the state's most recent SIP approved by the U.S. EPA within the region of the proposed action. These guidelines state that federally supported or funded activities must show that the proposed actions will not (1) cause or contribute to any new air quality standard violation in any area, (2) interfere with programs outlined in any SIP for maintenance of any standard, (3) increase the frequency or severity of any existing standard violation in any area, or (4) delay the timely attainment of any standard or any required interim emission reductions or other milestones in any area. The activities proposed herein are considered exempt from this rule as long as there is no increase in emissions above the *de minimis* levels specified in the rule. Therefore, a screening to determine the applicability of the conformance guidelines was performed. Table 3-2 presents the *de minimis* threshold levels presented in the conformity rule for non-attainment areas.

Ensuring reasonably foreseeable direct and indirect emissions do not exceed the *de minimis* thresholds comprises only half of the screening process. In addition to this requirement, a federal action must also not be considered regionally significant. A regionally significant action is defined as a federal action for which direct and indirect emissions of any pollutant represent 10 percent or more of a nonattainment or maintenance area's emissions inventory for that pollutant.

If a federal action meets both of the abovementioned criteria, it is exempt from further conformity analysis pursuant to 40 CFR Part 93.153. However, although an action may be considered exempt, should it be altered in any way causing an increase in the reasonably foreseeable emissions, or if attainment areas are reclassified based on changes to the NAAQS or the U.S.EPA-approved SIP, a revision to the conformity analysis may be required.

Table 3-2

Conformity Analysis *De Minimis* Thresholds

Pollutant	Degree of Non-attainment	*De Minimis* Level (tons/year)
Nonattainment Areas		
Ozone (VOCs or NO_2)	Serious	50
	Severe	25
	Extreme	10
	Marginal and Moderate (outside an ozone transport region)	100
	Marginal and Moderate (inside an ozone transport region)	50 (VOC) 100 (NO_2)
CO	All	100
PM_{10}	Moderate	100
	Serious	70
SO_2 or NO_2	All	100
Lead	All	25

Notes: CO – carbon monoxide
NO_x – nitrogen oxides
NO_2 – nitrogen dioxide
SO_2 – sulfur dioxide
VOC – volatile organic compound

Source: 40 CFR, Chapter I, Subchapter C, Part 51.853, last updated July 2003.

The impact on visibility from air pollutant emission sources is an issue with regard to federally mandated Class 1 areas, such as national parks and wilderness areas, where any appreciable deterioration in air quality is considered significant because it would reduce the perception that these areas are pristine, thus taking away from the enjoyment of the natural setting. Under the Organic Act of 1916, the National Park Service was created to "…conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (National Park Service 2004). According to the Department of the Interior, "Visibility impairment is the most ubiquitous air pollution-related problem in our national parks and refuges…all areas monitored for visibility show frequent regional haze impairment." (National Parks Conservation Association 2005)

Areas in attainment with the NAAQS are regulated under the Prevention of Significant Deterioration (PSD) program authorized by the CAA Part C, Sections 160–169. PSD areas require owners and/or operators of new or modified sources to obtain a PSD permit prior to construction of a major source (40 CFR Part 5221) in attainment or unclassified areas. A major source is defined by PSD regulations as being a specific type of source listed by the U.S. EPA that has a potential of emitting 100 tons per year of a regulated pollutant. Potential to emit is based on the maximum design capacity of a source and takes into account pollution control efficiency. If the U.S. EPA does not list a source, it may still be considered major if it has the potential to emit 250 tons per year of a regulated pollutant.

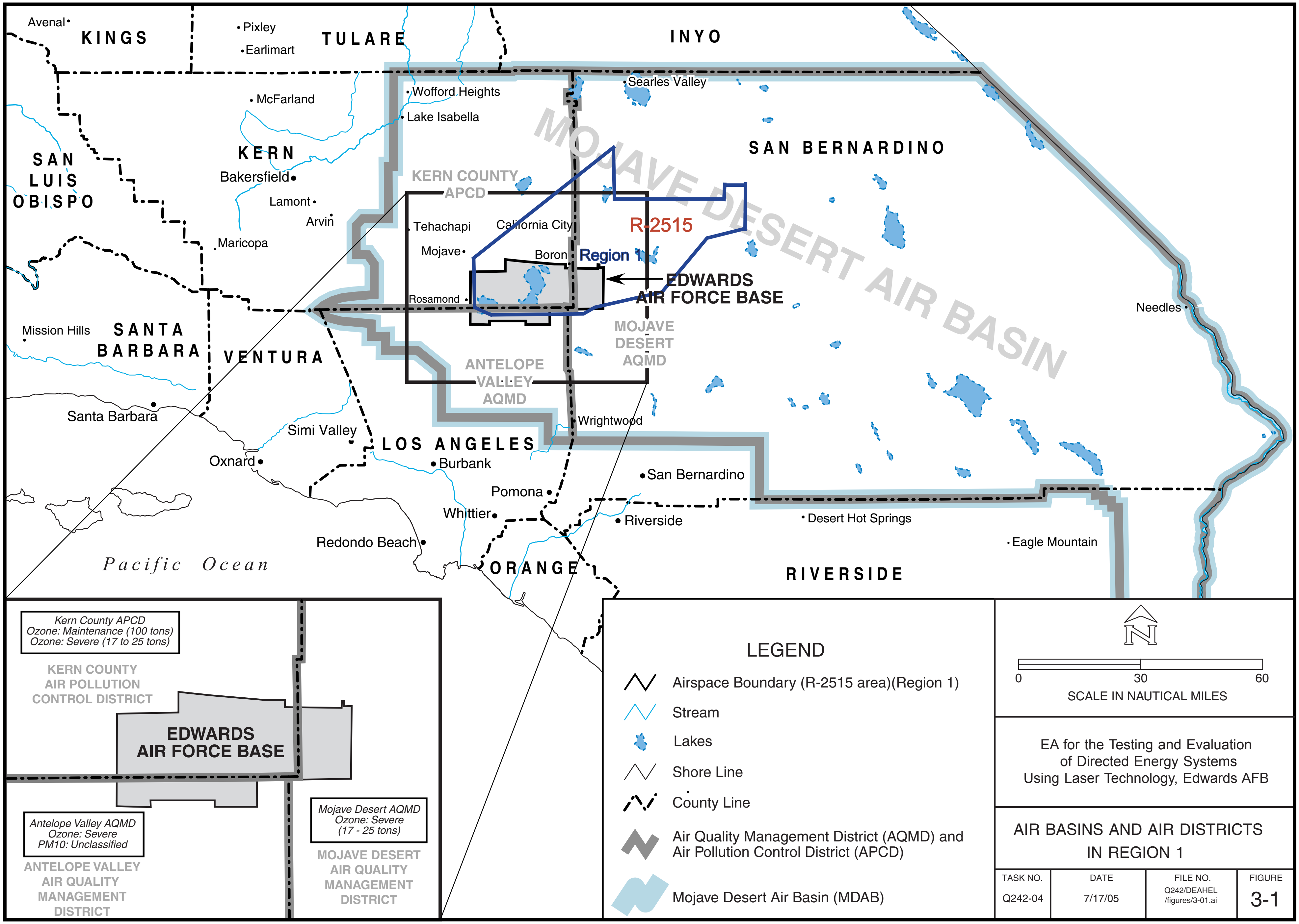
3.1.1 Air Quality—Region 1

The following sections provide a description of the climate, baseline air quality and emissions, and regulatory setting for Region 1. Although Alternatives A, B, and C differ, the affected environment for air quality for Region 1 would be essentially the same under each alternative. Region 1 extends into Kern, San Bernardino, and Los Angeles Counties within the Mojave Desert Air Basin (MDAB) of eastern California and is located within the jurisdiction of three local air districts: Kern County Air Pollution Control District (KCAPCD), Mojave Desert Air Quality Management District (MDAQMD), and Antelope Valley Air Quality Management District (AVAQMD) as shown in Figure 3-1.

The main base at Edwards AFB is located in the eastern portion of Kern County, which is under the jurisdiction of the KCAPCD. Because most activities proposed in Region 1 that could impact air quality would occur on Edwards AFB, discussions of environmental effects to air quality are analyzed in relation to baseline air quality in the KCAPCD and Edwards AFB.

Baseline Air Quality Emissions

The MDAB is currently impacted by fugitive dust emissions. Table 3-3 presents a summary of the attainment status of the project area in California. These data show that the majority of the region is in non-attainment of both state and national standards for PM_{10} and ozone. It should be noted that the area was recently designated as in attainment of the national 1-hour ozone standard but remains in nonattainment of both the national 8-hour ozone standard and the state standard.



Avenal
KINGS
Pixley
Earlimart
TULARE
INYO
Searles Valley
McFarland
Wofford Heights
Lake Isabella
SAN LUIS OBISPO
KERN
Bakersfield
Lamont
Arvin
Maricopa
KERN COUNTY APCD
SAN BERNARDINO
MOJAVE DESERT AIR BASIN
Tehachapi
California City
R-2515
Mojave
Boron
Region 1
EDWARDS AIR FORCE BASE
Rosamond
Needles
Mission Hills
SANTA BARBARA
VENTURA
MOJAVE DESERT AQMD
ANTELOPE VALLEY AQMD
Santa Barbara
Wrightwood
Simi Valley
LOS ANGELES
Oxnard
Burbank
San Bernardino
Pomona
Whittier
Riverside
Desert Hot Springs
Redondo Beach
Eagle Mountain
Pacific Ocean
ORANGE
RIVERSIDE
Kern County APCD
Ozone: Maintenance (100 tons)
Ozone: Severe (17 to 25 tons)
KERN COUNTY AIR POLLUTION CONTROL DISTRICT
EDWARDS AIR FORCE BASE
Antelope Valley AQMD
Ozone: Severe
PM10: Unclassified
ANTELOPE VALLEY AIR QUALITY MANAGEMENT DISTRICT
Mojave Desert AQMD
Ozone: Severe
(17 - 25 tons)
MOJAVE DESERT AIR QUALITY MANAGEMENT DISTRICT
LEGEND
Airspace Boundary (R-2515 area)(Region 1)
Stream
Lakes
Shore Line
County Line
Air Quality Management District (AQMD) and Air Pollution Control District (APCD)
Mojave Desert Air Basin (MDAB)
N
0
30
60
SCALE IN NAUTICAL MILES
EA for the Testing and Evaluation of Directed Energy Systems Using Laser Technology, Edwards AFB
AIR BASINS AND AIR DISTRICTS IN REGION 1
TASK NO. Q242-04
DATE 7/17/05
FILE NO. Q242/DEAHEL /figures/3-01.ai
FIGURE 3-1

Table 3-3

National/California Ambient Air Quality Standards

Attainment Designations for the Region 1 Project Area

County	Ozone	CO	NO_2	SO_2	PM_{10}
Kern/MDAB[a]					
National	A	U*	U*	U	N
California	N	U/A	A	A	U/N
San Bernardino/MDAB[b]					
National	N	U*	U*	U	N
California	N	A	A	A	N
Los Angeles County/MDAB					
National	N	U*	U*	U	U
California	N	A	A	A	N

Notes: Designation status: A=attainment, N=non-attainment, U=unclassified, and U*=unclassified/attainment.

a – With regard to the CAAQS for CO, the eastern portion of the county, located in the MDAB, is unclassified while the western portion of the county is in attainment. With regard to the NAAQS for PM_{10} the entire county within the MDAB is unclassified for the federal standard, except the Searles Valley Planning Area, which is non-attainment.

b – With regard to the NAAQS for ozone, the southwestern portion of San Bernardino County within the MDAB is non-attainment, and the northwestern and eastern portion are considered unclassified/attainment. The area was recently determined to be in attainment for the 1-hour national ozone standard but remains in non-attainment of the 8-hour standard. Therefore, for the purpose of this screening process, the area was considered to remain in non-attainment for ozone.

CO – carbon monoxide
MDAB – Mojave Desert Air Basin
NO_2 – nitrogen dioxide
PM_{10} – particulate matter equal to or less than 10 microns in diameter
SO_2 – sulfur dioxide

Source: California Air Resources Board 2003b. This information was supplemented with the latest information obtained from the *Federal Register*, April 22, 2004.

Therefore, this area was still considered a nonattainment area for ozone when conducting the screening process to determine applicability of the conformity guidelines. The area is in attainment or unclassified for the remaining criteria pollutants including CO, NO_2, and SO_2.

Eastern Kern County is located on the western edge of the Mojave Desert and is separated from populated valleys and coastal areas to the west and south by several mountain ranges. These valleys and coastal areas are the major source of ozone precursor emissions affecting ozone exceedances within Kern County's part of the MDAB. Although the sources of pollution in eastern Kern County do not by themselves result in exceedances of the federal ozone standards, this region is largely impacted by ozone transport from both the San Joaquin Valley Air Basin and the South Coast Air Basin.

Elevated levels of PM_{10} are primarily associated with fugitive dust, which is produced through a combination of high winds, dry soil conditions resulting from an arid climate, and ground-disturbing activities such as mining, agriculture, and construction.

Climate

Hot summers, cool winters, low rainfall, large diurnal ranges in temperature, and abundant sunshine characterize the climate at Edwards AFB. The arid climate of the region is mainly due to rainshadow effects of the Sierra Nevada and San Gabriel Mountains; the prevailing westerly winds deposit most of their moisture on the western slopes of these mountain ranges. Data collected at Edwards AFB from 1979 to 1989 are used to describe the climate of the project region (National Oceanic and Atmospheric Administration 2001).

The dominant weather feature in the project region is the Eastern Pacific high-pressure system. This system is most prevalent during the summer, when it occupies a northern position over the Pacific Ocean. Concurrent with the presence of high pressure, a low-level, thermal low-pressure system persists over the desert regions due to intense surface heating. The relative strengths and positions of the high-pressure system and the interior thermal trough are largely responsible for the general climatic conditions of the region.

Precipitation

During the winter, the Eastern Pacific high-pressure system weakens and moves southward, allowing polar storm systems to migrate through the region. Although the systems that reach the region have dried out considerably after traversing the elevated terrain to the west, they are responsible for most of the annual precipitation in the area. The average annual precipitation at Edwards AFB is 4.9 inches. Rainfall during the summer usually occurs from thunderstorms. Moisture from these storms originates from tropical air masses that move into the region from the south-southeast. Snow can occur in the region, although the average total is only about 2 inches per year.

Temperature

The annual average temperature at Edwards AFB is 62 degrees Fahrenheit (°F). Daily mean high and low temperatures for January are 57° F and 31° F, respectively. Daily mean high and low temperatures for July are 98° F and 66° F, respectively. Extreme temperatures that occurred during the 10-year monitoring period ranged from 4° F to 113° F.

Prevailing Winds

The combination of the Eastern Pacific high-pressure system over the Pacific Ocean and the thermal low over the interior desert produces a prevailing southwest wind in the region. Strong winds occur during the spring and summer, when the pressure gradient between the offshore Pacific High and the interior thermal trough is the greatest. However, extreme wind gusts can also occur with thunderstorms. Calm conditions increase during the fall and winter, when cold continental air replaces the thermal low and produces weak pressure gradients.

Regulatory Setting

In California, the CARB is responsible for enforcing air pollution regulations. The CARB has, in turn, delegated the responsibility of regulating stationary emission sources to local air agencies. There are no stationary sources of emissions associated with the proposed project. This area is within the eastern portion of Kern County, which is part of the MDAB. Therefore, the analysis will include only the portion of Kern County within the MDAB. In-flight aircraft emissions are generally unregulated within the project region, and are not considered for planning purposes above the mixing height.

The U.S. EPA typically uses 3,000 feet above ground level (AGL) as the default mixing height that inhibits the rapid vertical transfer of air. Pollutants emitted above the mixing height become diluted in the very large volume of air in the troposphere before they are slowly transported down to ground level. These emissions have little or no effect on ambient air quality. Therefore, air quality impacts below 3,000 feet AGL are the emphasis of the conformity analysis.

East Kern County is in attainment of the national 1-hour NAAQS for ozone and is also now under a federally approved SIP maintenance plan (*Federal Register* 2004). Currently, there is no federal conformity applicability for the 8-hour ozone NAAQS. The California standard has no legal basis under federal conformity; therefore, no conformity analysis is required with respect to these non-applicable standards. Since East Kern County is now considered a maintenance area, the only applicable conformity requirements are as specified in 40 CFR 93.153(a)(2), where East Kern County is under "all maintenance areas" and "maintenance areas outside of an ozone transport region." The applicable threshold values of 100 tons per year per action for VOCs and nitrogen oxides (NO_x) are in effect for East Kern County. Regional significance is still applicable.

Table 3-4 provides a summary of aircraft emissions at Edwards AFB in 2004 for comparison to the flights associated with test and evaluation of DE systems using laser technology at Edwards AFB. These are baseline emissions for the upper atmosphere within the airspace at Edwards AFB.

Table 3-4

Summary of Existing Emissions at Edwards AFB (tons/year)

VOC	CO	NO_x	SO_2	PM_{10}
204.82	457.55	195.82	18.63	11.95

Notes: Represents emissions that occurred in 2004 (U.S. Air Force 2005).
CO – carbon monoxide
NO_x – nitrogen oxides
PM_{10} – particulate matter equal to or less than 10 microns in diameter
SO_2 – sulfur dioxide
VOC – volatile organic compound

Edwards AFB is situated in the MDAB portion of Kern County; therefore, current and forecasted baseline emissions for this portion of Kern County are listed in Table 3-5.

Table 3-5

MDAB Portion of Kern County

Baseline and Forecasted Emission Baseline (tons/year)

Year	VOC	NO_x	PM_{10}
1985[a]	8,395	9,855	9,855
1990[a]	7,665	14,235	16,060
1995[a]	4,745	10,585	10,585
2000[a]	4,380	11,315	11,315
2005[b]	4,380	10,950	12,410
2010[b]	4,015	10,950	13,505

Table 3-5, Page 1 of 2

Table 3-5

MDAB Portion of Kern County

Baseline and Forecasted Emission Baseline (tons/year) (Continued)

Table 3-5, Page 2 of 2

Notes: a – Actual
b – Estimated
NO_x – nitrogen oxides
PM_{10} – particulate matter equal to or less than 10 microns in diameter
VOC – volatile organic compound

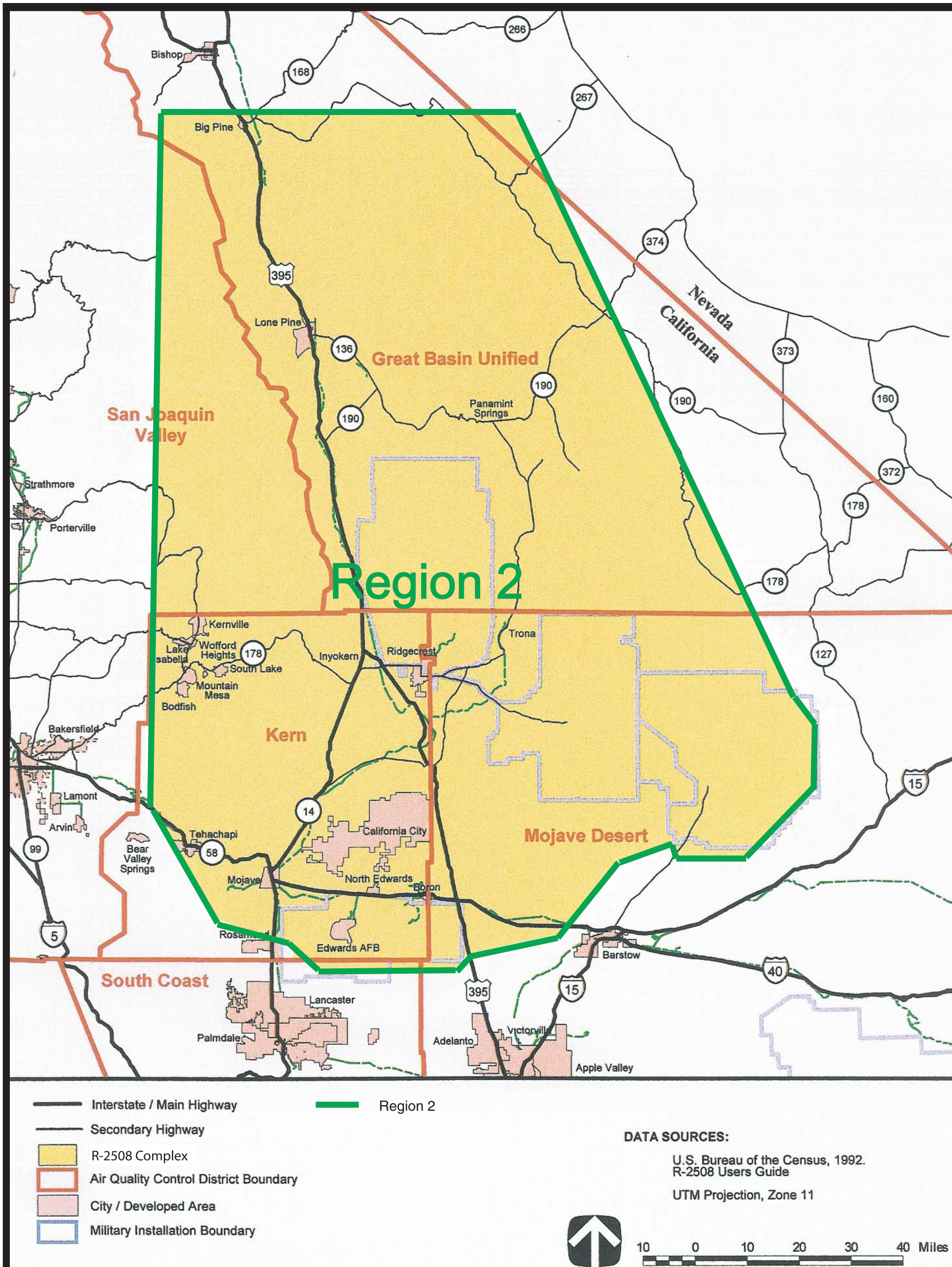
Source: California Environmental Protection Agency 2001.

3.1.2 Air Quality—Region 2

Region 2 extends into portions of Kern, Tulare, Fresno, Inyo, and San Bernardino Counties and spans three air basins including the MDAB, the San Joaquin Valley Air Basin, and the Great Basin Valleys Air Basin. Four local air districts maintain jurisdiction over the area: the KCAPCD, the San Joaquin Valley Air Pollution Control District (SJVAPCD), the Great Basin Unified Air Pollution Control District (GBUAPCD), and the MDAQMD (Figure 3-2). The current attainment status of the project area is summarized in Table 3-6.

The majority of proposed emissions from criteria air pollutants, or precursors thereof, for the Proposed Action and Alternatives are expected to occur below the mixing height of 3,000 feet AGL. Approximately 5 percent of aircraft-related events would generate emissions below 3,000 feet AGL. The Proposed Action Alternative proposes the use of the entire Region 2 area for testing, indicating that emissions above and below 3,000 feet AGL would occur. The climate of the Region 2 area is expected to be much the same as that of Region 1. The following provides a brief description of the baseline air quality for the Region 2.

The main difference between Alternatives A, B, and C is that in the case of Alternative B, only low power laser testing would be conducted at the LTAs in Region 1 and from laser platforms in Region 2. Under Alternative C the testing of the ABL would occur in the A/A mode from Region 1 or Region 2. The majority of emissions would be generated from the aircraft as opposed to the firing of the lasers. Therefore, emissions generated in Region 2 would be essentially the same for each alternative.



Air Quality Control Districts in the Region 2	Figure 3-2	Q242-04	7/06/05

Table 3-6

National/California Ambient Air Quality Standards

Attainment Designations for the Region 2 Project Area

County	Ozone	CO	NO_2	SO_2	PM_{10}
Kern County/MDAB[a]					
National	N	U*	U*	U	N
California	N	U/A	A	A	U/N
Tulare County/SJVAB					
National	N	A	A	A	N
California	N	A	A	A	N
Fresno County/SJVAB					
National	N	A	A	A	N
California	N	A	A	A	N
Inyo County/GBVAB					
National	A	A	A	A	N
California	U	A	A	A	N
San Bernardino County/ MDAB[b]					
National	N	U*	U*	U	N
California	N	A	A	A	N

Notes: Designation status: A=attainment, N=non-attainment, U=unclassified, and U*=unclassified/attainment.

a – With regard to the CAAQS for CO, the eastern portion of the county, located in the MDAB, is unclassified while the western portion of the county is in attainment. With regard to the NAAQS for PM_{10}, the entire county within the MDAB is unclassified for the federal standard, except the Searles Valley Planning Area, which is non-attainment.

b – With regard to the NAAQS for ozone, the southwestern portion of San Bernardino County within the MDAB is non-attainment, and the northwestern and eastern portion are considered unclassified/attainment. The area was recently determined to be in attainment for the 1-hour national ozone standard but remains in non-attainment of the 8-hour standard. Therefore, for the purpose of this screening process, the area was considered to remain in non-attainment for ozone.

CO – carbon monoxide
GBVAB – Great Basin Valleys Air Basin
MDAB – Mojave Desert Air Basin
NO_2 – nitrogen dioxide
PM_{10} – particulate matter equal to or less than 10 microns in diameter
SO_2 – sulfur dioxide
SJVAB – San Joaquin Valley Air Basin

Source: California Air Resources Board 2003b. This information was supplemented with the latest information obtained from the *Federal Register*, April 22, 2004.

3.2 AIRSPACE

3.2.1 Overview

Airspace is defined as the space that lies above a nation and comes under its jurisdiction. Although it is generally viewed as being unlimited, airspace is a finite resource that can be defined vertically and horizontally, as well as temporally, when describing its use for aviation purposes. Under Public Law (P.L.) 85-725, the FAA is charged with the safe and efficient use of the nation's airspace and has therefore established certain criteria and limits for its use. In order to accomplish its task, the FAA utilizes the National Airspace System (NAS).

There are two categories of airspace or airspace areas: regulatory (Class A, B, C, D, and E airspace areas, restricted and prohibited areas); and non-regulatory (military operations areas [MOAs], warning areas, alert areas, and controlled firing areas).

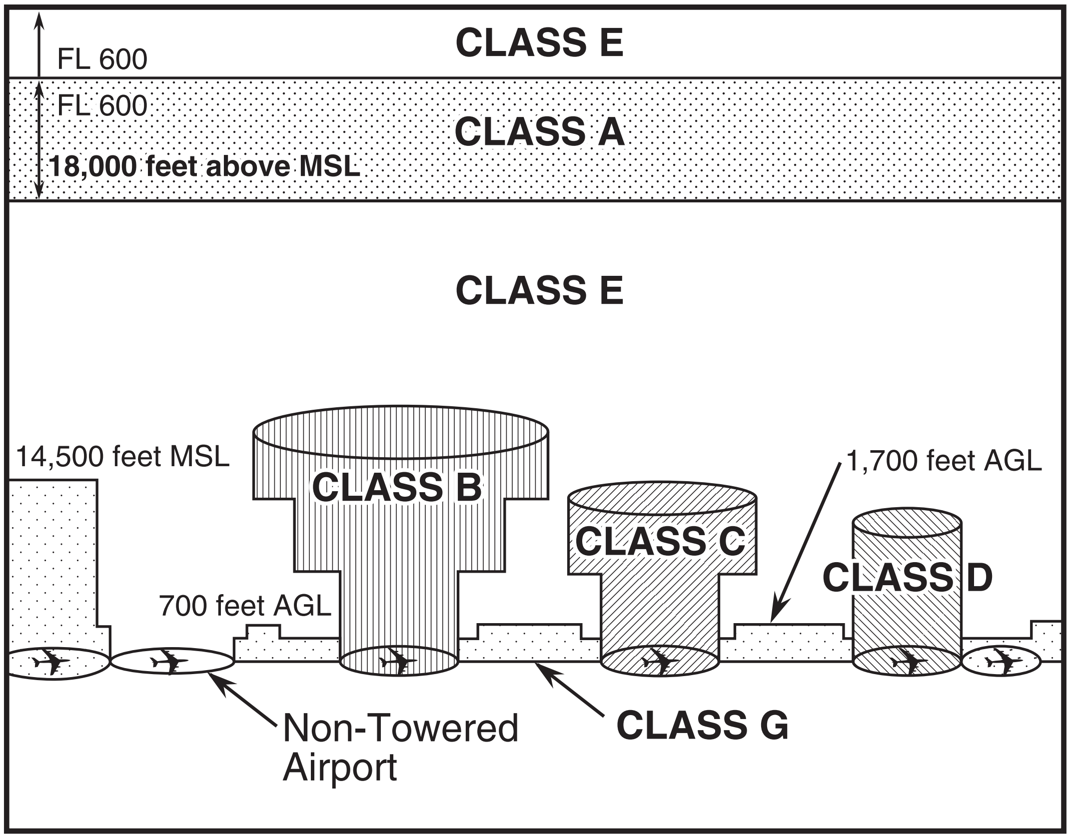
Within these two categories there are four types of airspace: controlled, uncontrolled, special use, and other. Each of these types is dictated by:

- The complexity or density of aircraft movements;
- The nature of the operations conducted within the airspace;
- The level of safety required; and
- The national and public interest.

In generic terms the FAA describes controlled airspace as Class A, Class B, Class C, Class D, and Class E airspace. Uncontrolled airspace is Class G airspace from 700 to 1200 feet AGL and not designated as Class A, Class B, Class C, or Class D. Class G airspace also includes airspace above flight level (FL)[1] 600 that is not designated as Class E airspace. Figure 3-3 shows the different classifications of controlled and uncontrolled airspace.

Test and evaluation of DE systems using laser technology will be conducted in SUA

[1] Flight levels are used to describe altitudes above and including 18,000 feet mean sea level.



LEGEND

Class A
Class B
Class C
Class D
Class E
Class G

✈	Airport
FL	Flight Level
MSL	Mean Sea Level
AGL	Above Ground Level

EA for Testing and Evaluation
of DE Systems Using Laser Technology
at Edwards AFB

FAA CLASSES OF CONTROLLED AND UNCONTROLLED AIR SPACE

TASK NO.	DATE	AI FILE NO.	FIGURE NO.
Q242-04	6/25/05	Q242/HELDEA/3-3.ai	3-3

Special use airspace consists of airspace wherein activities must be confined because of their nature, or wherein limitations are imposed upon aircraft operations that are not a part of those activities, or both (FAA 2004). Except for controlled firing areas, SUA areas are depicted on aeronautical charts. Generally SUAs consist of the following:

- Prohibited Areas. There are no prohibited areas within the ROI for the Proposed Action or Alternatives.
- Restricted Areas. These are areas that denote the existence of unusual, often invisible hazards to aircraft such as artillery firing, aerial gunnery, or guided missiles. An aircraft may not enter a restricted area unless permission has been obtained from the controlling agency. Restricted areas are depicted on aeronautical charts and are published in the *Federal Register*.
- Warning Areas. There are no warning areas within the region of interest for the Proposed Action or Alternatives.
- Military Operations Areas. These are areas that consist of airspace of defined vertical and lateral limits established for the purpose of separating certain military training activities from instrument flight rules (IFR) traffic. There is no restriction against a pilot operating in visual flight rules (VFR) in these areas; however, a pilot should be alert since training activities may include acrobatic and abrupt maneuvers. MOAs are depicted on aeronautical charts.
- Alert Areas. There are no alert areas within the region of interest for the Proposed Action or Alternatives.
- Controlled Firing Areas (CFAs). The Trona CFA is the only CFA within the ROI for the Proposed Action or Alternatives. A CFA is an area in which ordnance firing is conducted under controlled conditions so as to eliminate hazards to aircraft in flight. The distinguishing feature of the CFA, as compared to other SUA, is that activities are suspended immediately when spotter aircraft, radar, or ground lookout positions indicate that an aircraft might be approaching the area. These areas are not charted since they do not cause a non-participating aircraft to change its flight path (FAA 2004).

Detailed information on the restricted areas in the R-2508 Complex is available in the *R-2508 Users Guide* that can be found at http://r2508.edwards.af.mil/. The targets used to support the testing and evaluation of directed energy systems using laser technology will be entirely within restricted area R-2515 within the R-2508 Complex.

3.2.2 Airspace—Region 1

3.2.2.1 Special Use Airspace

The Region 1 controlled airspace includes restricted area R-2515, which is a part of the R-2508 Complex. Only a small area of the Isabella and Buckhorn MOAs, on the western and southern border of Edwards AFB, are within the Region 1 ROI for SUA (Figure 3-4).

3.2.2.2 Military Training Routes

Region 1 contains one IFR (Instrument Route [IR]-236) and two VFR (Visual Route [VR]-1205 and VR-1206) low-altitude training routes and one slow-speed, low-altitude training route (SR-390) (Figure 3-5). All routes within the ROI that transit the boundaries of restricted area R-2515 are governed by the flight restrictions and requirements to "see and avoid" other aircraft when operating under VFR flight rules. All routes are designated as "military assumes responsibility for separation of aircraft" (MARSA) operations, which are established by coordinated scheduling. Hours of operation are normally daylight hours. Other hours are by Notice to Airmen (NOTAM), except for VR-1205 and VR-1206 which have continuous hours of operation (National Geospatial-Intelligence Agency 2004).

3.2.2.3 En Route Victor Airways and Jet Routes

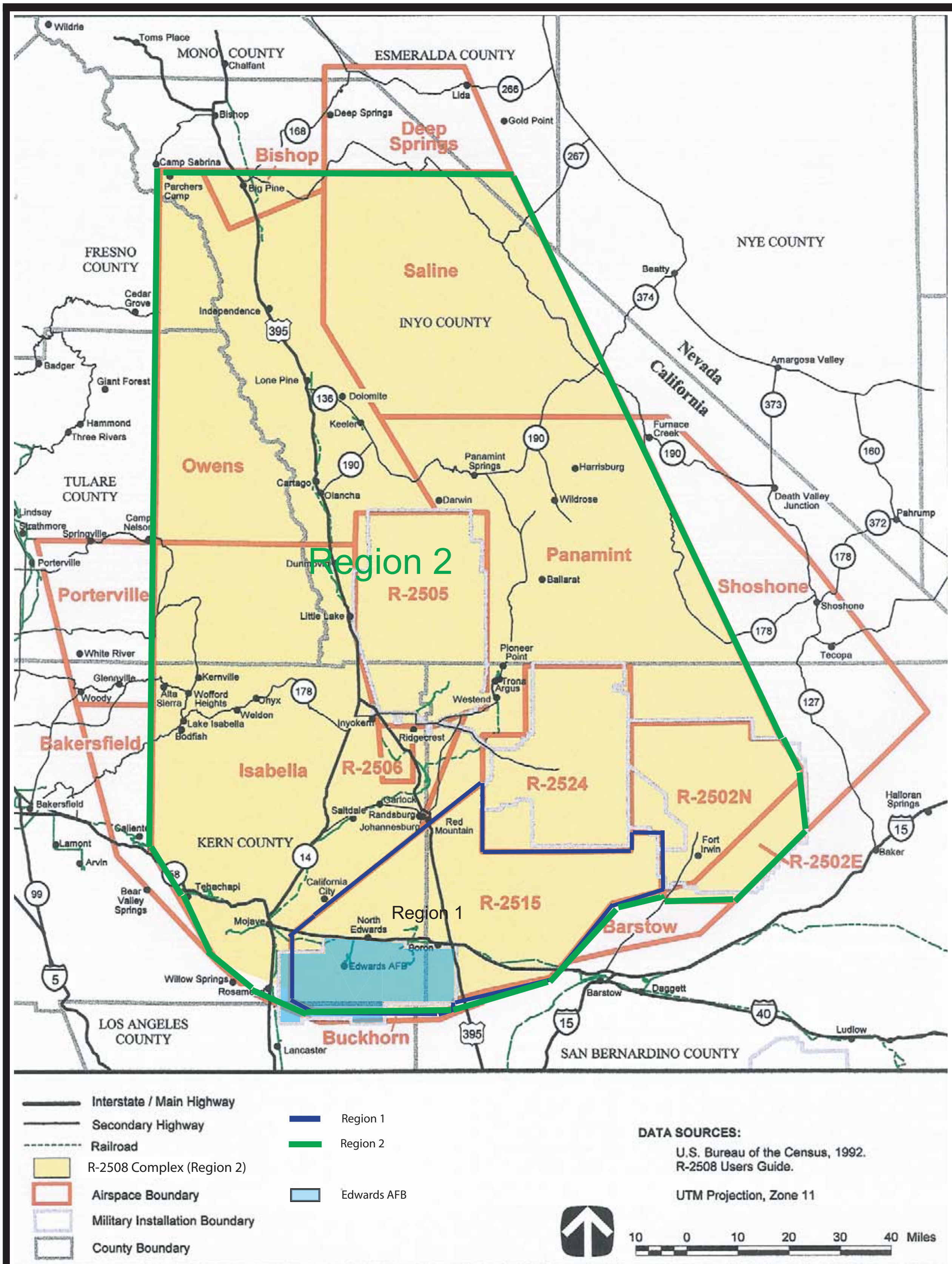
There are no en route victor airways or jet routes over Edwards AFB.

3.2.2.4 Airports/Airfields/Airstrips

The only airports/airfields/airstrips in Region 1 include the hard surface runways at Borax, Boron, Edwards AFB, and Edwards AF Auxiliary plus the dry lakebed runways on Rogers Dry Lake and Rosamond Dry Lake (see Figure 3-6).

3.2.2.5 Air Traffic Control

The Region 1 area for Alternatives A, B, and C lies exclusively within the Los Angeles Air Route Traffic Control Center's (ARTCC's) boundaries (National Aeronautical Charting Office [NACO] 2004a).



Airspace in Regions 1 and 2 | Figure 3-4 | Q242-04 | 1/06/05

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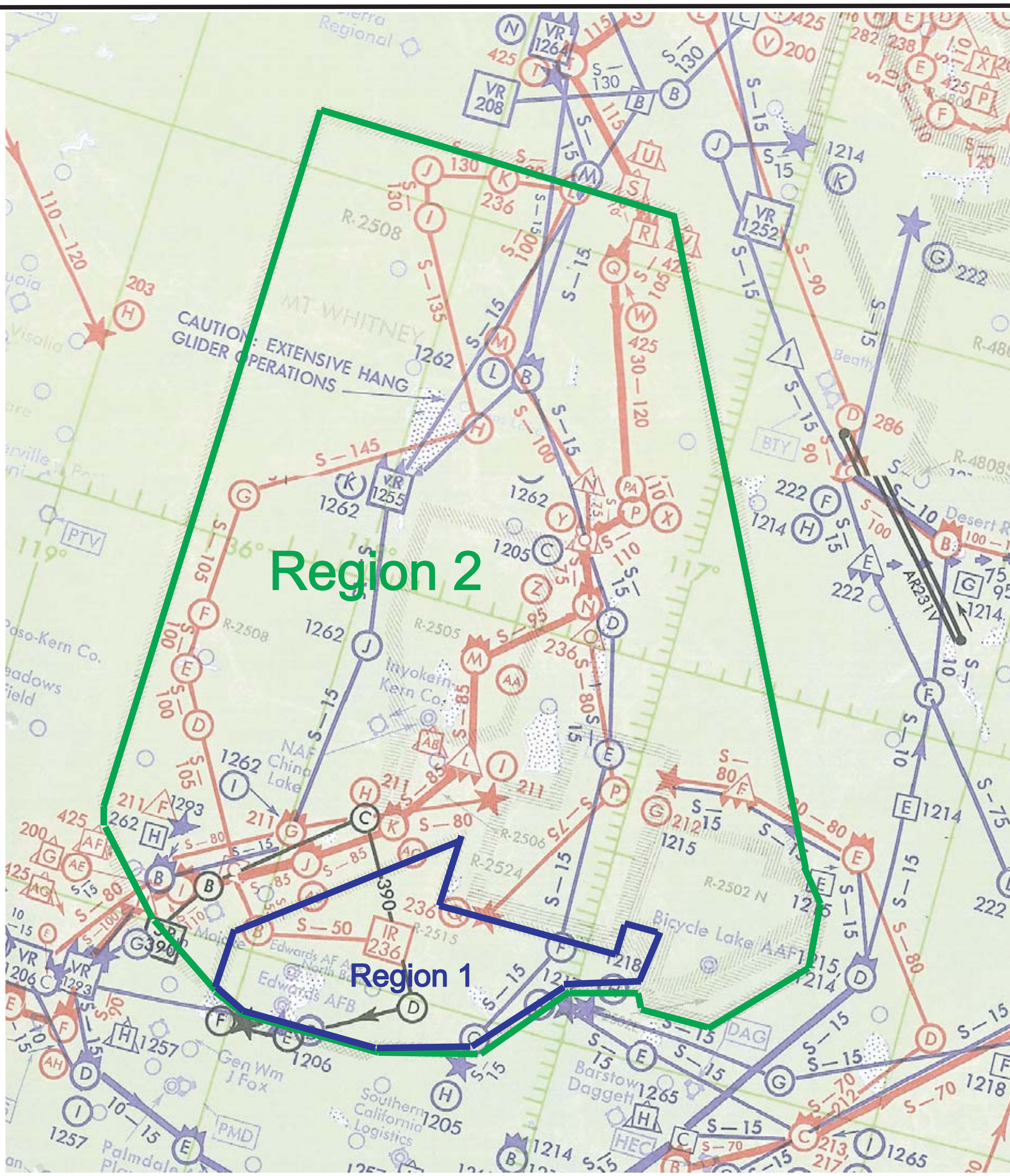

LEGEND

Special Use Airspace in the R-2508 Complex

(Region 1)

(Region 2)

Civilian Airport

Military Airfields

Instrument Route (IR) Military Training Route

Visual Route (VR) Military Training Route

Slow Route (SR) Military Training Route

0 15 30

SCALE IN NAUTICAL MILES

EA for the Testing and Evaluation of Directed Energy Systems Using Laser Technology Edwards Air Force Base, California

MILITARY TRAINING ROUTES IN THE R-2508 COMPLEX (Regions 1 and 2)

TASK NO.	DATE	FILE NO.	FIGURE NO.
Q242-03	1/11/05	Q242FIGS/3-04.ai	3-5

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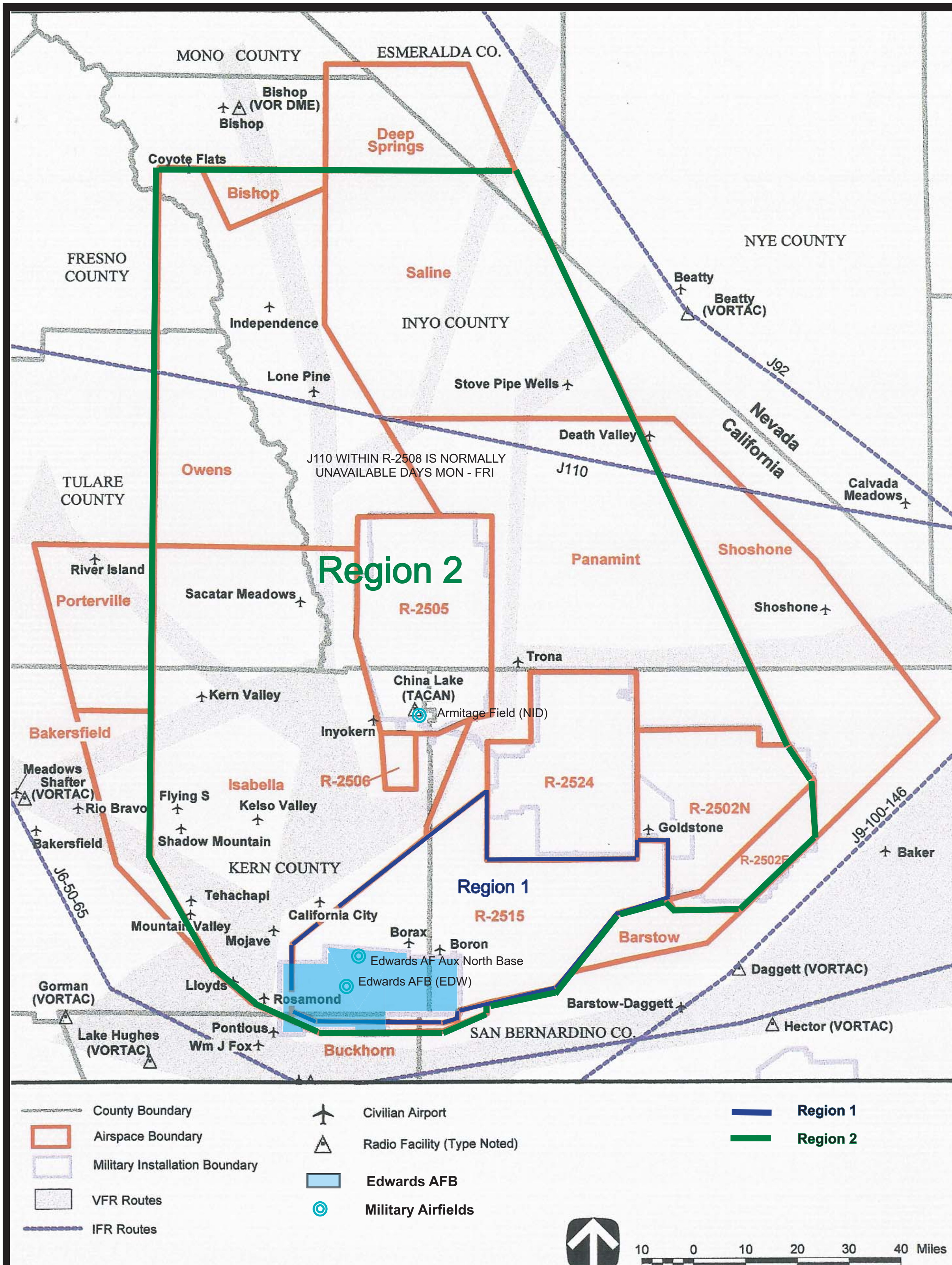


Jet Routes, Airports, and Airfields in Regions 1 and 2	Figure 3-6	Q242-04	1/06/05

The controlling agency for restricted area R-2515 is Hi-Desert Terminal Radar Approach Control (Hi-Desert TRACON). During the published hours of use (identified in Table 3-7), the using agency is responsible for controlling all military activity within the SUA and ensuring that its perimeters are not violated. When the airspace is scheduled to be inactive, the using agency releases it back to the controlling agency (Hi-Desert TRACON), and in effect, the airspace is no longer restricted. If no activity is scheduled during some of the published hours of use, the using agency releases the airspace to the controlling agency for non-military operations for that period of inactivity (Illman 1993).

3.2.3 Airspace—Region 2

3.2.3.1 Special Use Airspace

Table 3-7 gives the name/number, effective altitude, time of use, and controlling agency for the SUA within Alternatives A, B, and C. Special use airspace within Alternatives A and B is shown in Figure 3-4.

Table 3-7

Special Use Airspace In and Surrounding Alternatives A, B, and C

Number/Name	Effective Altitude (feet)	Time of Use (PST)	Controlling Agency
R-2508 Complex			
R-2502E	Unlimited	Continuous	Hi-Desert TRACON
R-2502N	Unlimited	Continuous	Hi-Desert TRACON
R-2505	Unlimited	Continuous	Hi-Desert TRACON
R-2506	6,000 MSL	0600–1800 M– F[1]	Hi-Desert TRACON
R-2508	FL 200 to Unlimited	Continuous	Hi-Desert TRACON
R-2515	Unlimited	Continuous	Hi-Desert TRACON
R-2524	Unlimited	Continuous	Hi-Desert TRACON
Bakersfield MOA	2,000 AGL–FL 180	0600–1800 M– F[1]	ZLA CNTR
Barstow MOA	200 AGL–FL 180	0600–1800 M– F[1]	Hi-Desert TRACON
Bishop MOA	200 AGL–FL 180	0600–1800 M– F[1]	ZLA CNTR
Buckhorn MOA	200 AGL[2]	0600–1800 M– F[1]	Hi-Desert TRACON
Isabella MOA	200 AGL[2,3]	0600–1800 M– F[1]	Hi-Desert TRACON
Owens MOA	200 AGL–FL 180[3]	0600–1800 M– F[1]	Hi-Desert TRACON
Panamint MOA	200 AGL–FL 180	0600–1800 M– F[1]	Hi-Desert TRACON
Porterville MOA	2,000 AGL–FL 180	0600–1800 M– F[1]	Hi-Desert TRACON

Table 3-7, Page 1 of 2

Table 3-7

Special Use Airspace In and Surrounding Alternatives A, B, and C (Continued)

Number/Name	Effective Altitude (feet)	Time of Use (PST)	Controlling Agency
Saline MOA	200 AGL–FL 180	0600–1800 M– F[1]	Hi-Desert TRACON
Shoshone North MOA	200 AGL–FL 180	0600–1800 M– F[1]	ZLA CNTR
Shoshone South MOA	FL 180–FL 600	0600–1800 M– F[1]	ZLA CNTR

Table 3-7, Page 2 of 2

Notes: 1-Other times by NOTAM.
2- Up to but not including FL 180.
3- Excluding 3,000 feet AGL and below over Domeland Wilderness Area.
AGL- above ground level
FL- flight level (FL 180 = approximately 18,000 feet above mean sea level)
MOA- Military Operations Area
NOTAM- Notice to Airmen
R- restricted
TRACON- Terminal Radar Control

Source: National Aeronautical Charting Office 2004a and b.

There are over 20,000 square miles of airspace in Region 2 that have been designated as restricted for use by DoD, National Aeronautics and Space Administration (NASA), and other government agencies. This airspace is over an area 140 miles north to south (Bishop to Edwards AFB) and 110 miles east to west (Nevada state line to Bakersfield). Known by its FAA designation as the R-2508 Complex, this airspace in Region 2 is scheduled, monitored, regulated, and controlled to provide safe aircraft test areas. Aircraft operational characteristics and altitudes are regulated in this airspace to minimize ground-based conflicts. The R-2508 Complex encompasses large portions of Inyo, Kern, San Bernardino, and Tulare counties in east-central California. It also includes a portion of Fresno and Los Angeles counties in California and extends into Nevada’s Esmeralda County (NASA 1997a).

There are no warning, prohibited, or alert special use airspace areas within Alternatives A, B, and C (National Geospatial-Intelligence Agency 2004).

3.2.3.2 Military Training Routes

Alternatives A, B, and C contain several IFR and VFR low-altitude training routes and one slow-speed, low-altitude training route (SR-390) (see Figure 3-5). All routes within the ROI that transit the boundaries of the R-2508 Complex are governed by the flight restrictions and requirements to “see and avoid” other aircraft when operating under VFR flight rules. All routes are designated as MARSA operations, which are established by coordinated scheduling. Hours of operation are normally daylight hours. Other hours are by NOTAM, except for IRs 211 and 212 and VRs 1206, 1206, 1214, 1215, 1217, and 1293, which have continuous hours of operation (National Geospatial-Intelligence Agency 2004). All test and evaluation flight profiles for Alternatives A, B, and C are inside the boundaries of the R-2508 Complex.

3.2.3.3 En Route Victor Airways and Jet Routes

There are no en route victor low-altitude (up to but not including 18,000 feet above mean sea level [MSL]) airways that transect the airspace within Alternatives A, B, and C (NACO 2004c) (see Figures 3-5 and 3-6). The J110 jet route transects the northern one-third of the R-2508 Complex; however this jet route is normally unavailable during daylight hours Monday through Friday (NACO 2004a).

3.2.3.4 Airports

There are several public-use civilian airports within the ROI for Alternatives A, B, and C. These include Borax, Boron, California City Municipal, Death Valley, Goldstone/GTS Private, Independence, Inyokern, Kern Valley, Lone Pine, Mojave, Mountain Valley, Rosamond Skypark, Shoshone, Stove Pipe Wells, Tehachapi Municipal, and Trona (95th Air Base Wing [95 ABW] and AFFTC 2005). In addition to Edwards AFB and Edwards AF Auxiliary plus the dry lakebed runways on Rogers Dry Lake and Rosamond Dry Lake, Naval Air Weapons Station (NAWS) China Lake/Armitage Field, are the only military airfields (Figures 3-5 and 3-6) (NACO 2004a) in Region 2.

3.2.3.5 Air Traffic Control

Alternatives A, B, and C lie exclusively within the Los Angeles ARTCC's boundaries (NACO 2004a). The controlling agency for the Restricted Areas and MOAs within restricted area R-2515 is Hi-Desert TRACON. During the published hours of use (identified in Table 3-7), the using agency is responsible for controlling all military activity within the SUA and ensuring that its perimeters are not violated. When the airspace is scheduled to be inactive, the using agency releases it back to the controlling agency (Hi-Desert TRACON), and in effect, the airspace is no longer restricted. If no activity is scheduled during some of the published hours of use, the using agency releases the airspace to the controlling agency for non-military operations for that period of inactivity (Illman 1993).

3.3 CULTURAL RESOURCES

3.3.1 Overview

Cultural resources are defined as historic properties, landscapes, cultural items, archeological resources, sacred sites, or collections subject to protection under the National Historic Preservation Act; the Archeological Resources Protection Act ; the Native American Graves Protection and Repatriation Act ; EO 13007, *Indian Sacred Sites*; and the *Guidelines on Curation of Federally Owned and Administered Collections* (36 CFR Part 73).

Cultural resources are locations of human activity, occupation, or use. They include expressions of human culture and history in the physical environment, such as buildings, structures, objects, districts, or other places. Cultural resources can be natural features, plants, and animals that are considered to be important to a culture, subculture, or community. Cultural resources also include traditional lifeways and practices. For this EA, cultural resources have been organized into the categories of prehistoric resources, historic resources, and traditional cultural properties (TCPs) and practices. These types are not exclusive and a single cultural resource may have multiple components.

Prehistoric cultural resources refer to any material remains, structures, and items used or modified by people before Euro-Americans established a presence in the region. In southern California, the earliest direct contact of native populations with Euro-Americans occurred on the coast and Channel Islands and later in inland areas. The earliest brief encounters by explorers began in the mid-sixteenth century followed by colonization and settlement by the late eighteenth century. Examples of prehistoric cultural resources recorded in the region include the archaeological remains of villages, camps, quarries, rock shelters, rock art, milling features, cemeteries and scatters of prehistoric artifacts, such as stone tool-making debris or groundstone artifacts.

Historic cultural resources include the material remains and landscape alterations that have occurred since the arrival of Euro-Americans in the region. Examples of historic cultural resources in the region include homestead and agricultural features, foundations, roads, buildings, scatters of historic artifacts, post-contact Native American villages, and locations or structures that are associated with historic events or people.

Traditional cultural properties are places associated with the cultural practices or beliefs of a living community. These sites are rooted in the community's history and are important in maintaining cultural identity. Examples of TCPs include natural landscape features; places used for ceremonies and worship;

ancestral villages or burial sites; places where plants are gathered that are used in traditional medicines and ceremonies; places where artisan materials are found; places where traditional arts are practiced or passed on; and features of traditional subsistence systems. Impacts to the continued use and maintenance of traditions are considered in NEPA analyses.

3.3.2 Cultural Resources—Region 1

Cultural resources related to flight and ground activities on Edwards AFB will be discussed in this section. Other potentially affected cultural resources outside Edwards AFB but inside restricted area R-2515 would be the same as addressed in *EA for Continued Use of R-2515 Restricted Area* (Edwards AFB 1998). Edwards AFB has conducted comprehensive cultural resource identification with more than 450 archaeological surveys covering more than 137,455 acres having been completed. As a result of this work, 1,702 prehistoric sites, 1,349 historic sites, and 82 military sites on Edwards AFB have been recorded (Crosby 2005). Thirteen traditional cultural properties also have been recorded (Norwood 2003).

The most common prehistoric site types are lithic scatters, temporary camps, hearth features, and milling stations. Common historic archaeological site types include refuse scatters, homestead sites, mining sites, and various agricultural features. Military resources include the sites of inactive military camps, buildings, or ruins (Earle *et al*. 1997; Ronning *et al*. 2000).

Most of the archaeological sites have not been formally evaluated for the National Register of Historic Places (NRHP). Nineteen prehistoric sites and eight historic archaeological sites have been determined individually eligible for NRHP with the concurrence of the California Office of Historic Preservation. Another seventy are considered potentially eligible, and sixty-eight have been determined as not eligible for the NRHP. There are two archaeological historic districts, one at North Base—consisting of five contributing sites—and the South Base Sled Track.

Studies of the built environment on Edwards AFB generally address military buildings and structures associated with three historic themes: World War II, the Cold War, and Man in Space. Many of the military buildings and structures on Edwards AFB are less than 50 years old and must possess "exceptional significance" to be found eligible for the NRHP. To date, 82 buildings or structures have been determined eligible. Another 29 are considered potentially eligible and 229 have been determined not eligible for the NRHP.

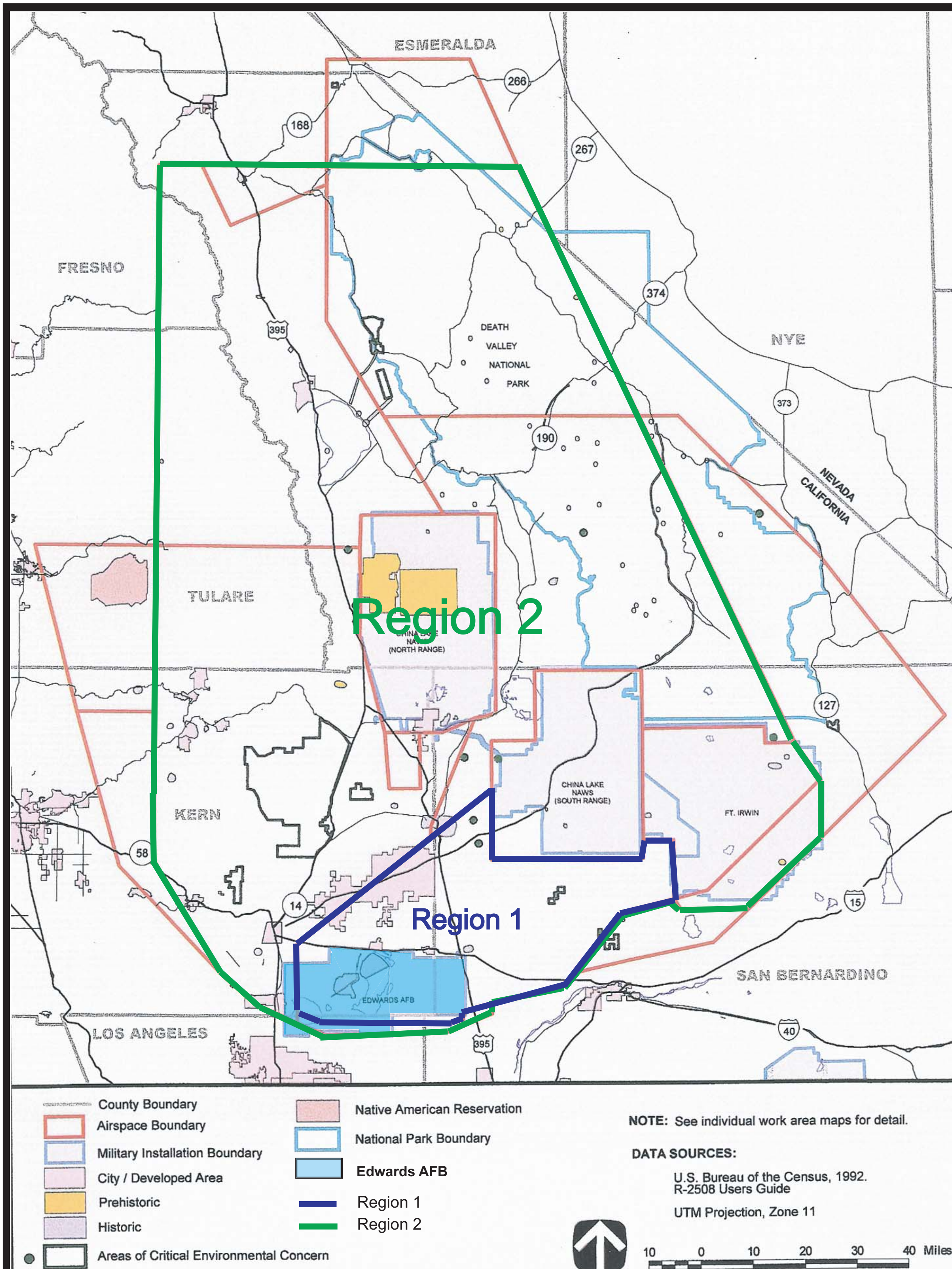
There are four historic building districts. Jet Propulsion Laboratory includes 53 eligible contributing elements. Air Force Research Laboratory includes 5 eligible contributing elements, 27 potentially eligible structures, and 69 unevaluated structures. The South Sled Track includes 10 eligible buildings and structures. The X-15 Engine Test Complex consists of 7 eligible buildings (Norwood 2003).

Rogers Dry Lake is a National Historic Landmark and the primary resource responsible for the establishment of Edwards AFB and the Dryden Flight Research Facility. The lakebed is associated with historic aviation developments including the flight of the Bell X-1, the first plane to break the sound barrier, in 1947 and the first Space Shuttle landing in 1981 (Earle *et al*. 1998).

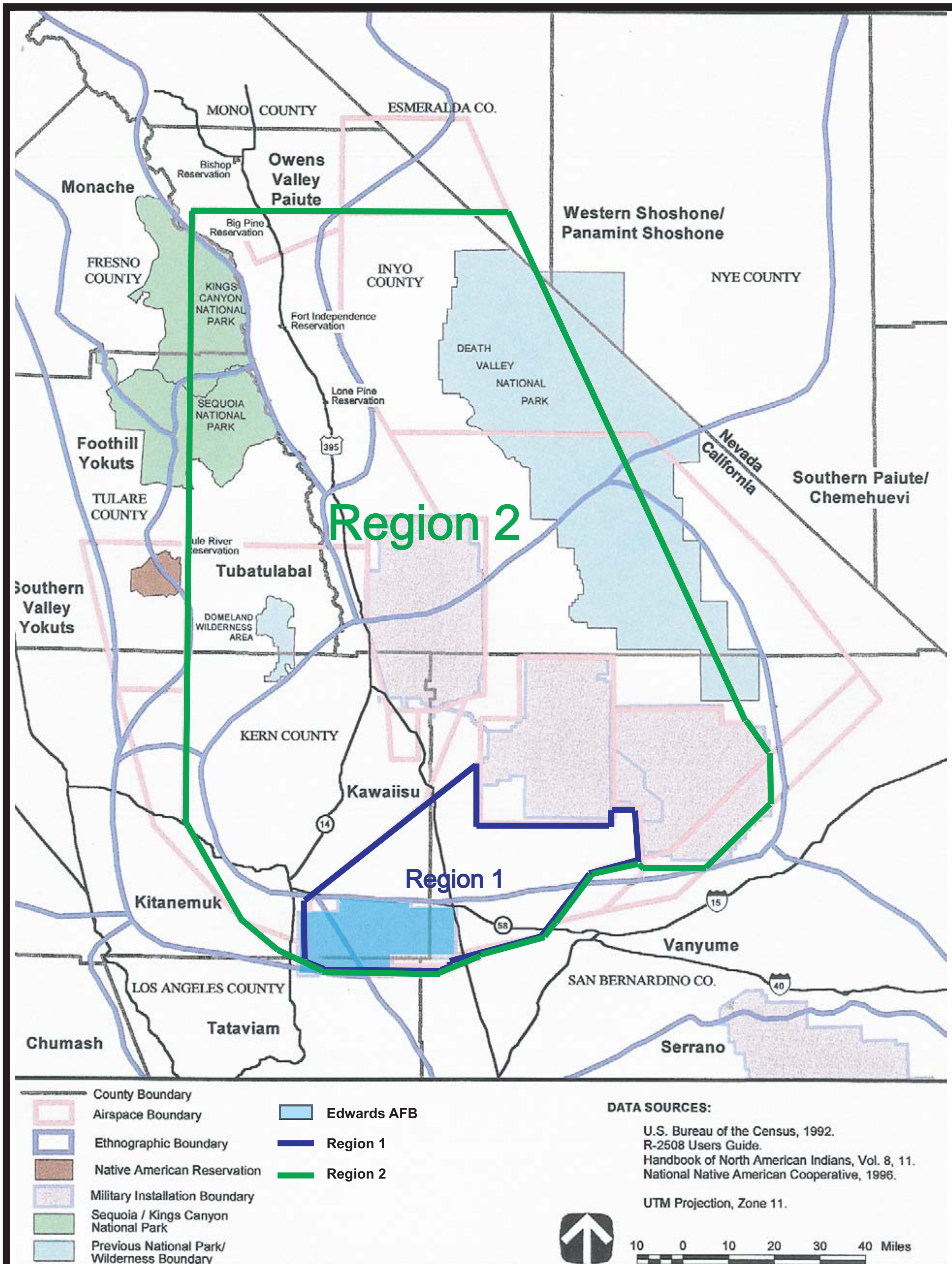
3.3.3 Cultural Resources—Region 2

Cultural resources in Region 2 for Alternatives A, B, and C include a wide variety of physiographic features and environments (Figure 3-7). The types of cultural resources present reflect the complexities of the human use and modification of these lands during the recent past and throughout at least 10,000 years of human occupation. Hundreds of cultural resources are recorded below the R-2508 and R-2515 restricted areas; however a full inventory of all cultural resources in the ROI has not taken place. Integrity of setting is generally most relevant to the significance of buildings and TCPs rather than archaeological sites.

Indian reservations within the boundaries of Region 2 include the Independence Reservation near Independence, California; the Lone Pine Reservation near Lone Pine, California; the Tule River Indian Reservation near Porterville, California; and the Big Pine Indian Reservation near Big Pine, California, on the northern edge of the R-2508 Complex (Figure 3-8). Non-reservation settlements also occur that include the Timbisha in Death Valley National Park and scattered enclaves in towns and ranches throughout the region (95 ABW and AFFTC 2005). A number of sensitive sites for Native Americans have been identified in the eastern portion of the R-2508 Complex based on archival, ethnological, and archaeological information and interviews with representatives of the Western Shoshone, Owens Valley Paiute, Kawaiisu, Southern Paiute and Chemehuevi, and Timbisha (Cultural Systems Research, Inc. 1987). These sites retain significance for Native Americans based on present or past beliefs, habitation, or use and include the Saline Valley, Panamint Valley, the Searle Dry Lake, Superior Valley, and Coyote Lake Basin. Native American concerns may include land uses which may impact traditional activities such as hunting, resource collecting, or religious practices, as well as treatment of archaeological materials since "…all archaeological remains are of significance to the Native American community in that they represent the material remnants of their past history" (Busby *et al.* 1979).



Cultural Resources in Regions 1 and 2	Figure 3-7	Q242-04	1/06/05



Native American Reservations and Boundaries in the Regions 1 and 2	Figure 3-8	Q242-04	1/06/05

The most sensitive areas of the R-2508 Complex for Native American resources are the Isabella, Porterville, and Bakersfield areas (Jawbone-Butterhead area, Tule Lake Reservation, Black Mountain, and Kern River); the Saline and Deep Springs Areas (Saline Valley); the Panamint and Shoshone Areas (Panamint Valley); NAWS China Lake restricted areas R-2505, R-2506, and R-2524 (Coso Hot springs and Superior Valley); and Barstow Area (Coyote Lake Basin) (95 ABW and AFFTC 2005).

3.4 ENVIRONMENTAL JUSTICE AND THE PROTECTION OF CHILDREN

Executive Order 12898*, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, requires federal agencies to develop environmental justice strategies and make environmental justice a part of their mission by identifying and addressing disproportionately high adverse effects of their activities on minority and low-income populations. Agencies are required to ensure that their programs and activities affecting human health or the environment do not directly or indirectly use criteria, methods, or practices that discriminate on the basis of race, color, or national origin.

Executive Order 13045, *Protection of Children from Environmental Health and Safety Risks* (April 21, 1997) requires federal agencies to address the potential for disproportionately high and adverse environmental effects of their actions on children. The Order further requires federal agencies ensure that their policies, programs, activities, and standards address these risks. This document has been prepared in compliance with EO 13045 to identify and, if necessary, mitigate health and safety risks with the potential to disproportionately affect children.

Alternatives A, B, and C would not target minority or low-income populations or the protection of children or use them as factors in the selection process. The Proposed Action and Alternatives would not directly create environmental health and safety risk for children.

3.5 GEOLOGY AND SOILS

Geologic resources consist of naturally formed minerals, rocks, and unconsolidated sediments. Soil refers to the uppermost layers of surficial geologic deposits and the weathering of those deposits. Concerns associated with the geologic setting, which could either affect or be affected by a proposed project, include topography and soil erosion. Normal military activities at Edwards AFB or within the R-2508 Complex (Region 2) do not increase exposure to seismic hazards or other geologic hazards including landslides, subsidence, or volcanic eruption.

3.5.1 Geology and Soils—Region 1

The only potentially affected geology and soils in Region 1 are located on Edwards AFB; therefore the discussion on geology and soils in Region 1 will be limited to a description of the geology and soils at Edwards AFB.

3.5.1.1 Topography

Edwards AFB is located in the Antelope Valley, a broad alluvial plain lying southwest of the Tehachapi Mountains and north of the San Gabriel Mountains. Low ranges of bedrock hills occasionally interrupt the generally flat terrain of the valley floor; the lower flanks of the hills are blanketed by Quaternary-aged alluvial fans consisting of water-laid sand and gravel deposits. The valley floor is composed of several closed topographic depressions that contain the three major playas: Rogers, Rosamond, and Buckhorn Dry Lakes. Playa deposits consist of thick, bedded clay and sand, and interfinger with the encroaching alluvial fan deposits. Playa margins have shoreline sand deposits from the wetter middle and late Pleistocene climates when the lakes were filled with water. In the lower elevations, wind-laid deposits form in the dunes and hummocks (Edwards AFB 2002).

Edwards AFB can be characterized by having the following three physiographic regions:

- An upland area located in the northwest portion of the base north of Rosamond and west of Rogers Dry Lake. The area is characterized by low, rounded hills, including Bissel and Rosamond Hills, with elevations ranging between 2,270 and 3,200 feet above MSL.

- A lowland area occupying the central and southwestern portions of the base. The lowland area includes Rosamond, Buckhorn, and Rogers Dry Lakes and the intervening area. It extends from the northern boundary of the base to the southern boundary and has a relief of approximately 400 feet, with elevations ranging from 2,270 to 2,675 feet above MSL.

- An upland area that extends east of Rogers Dry Lake to the eastern boundary of Edwards AFB. Leuhman Ridge and Haystack Butte, both over 3,400 feet above MSL are the two prominent relief features in this area. Elevations in this area range from approximately 2,400 to over 3,400 feet above MSL and are the highest of the three physiographic areas on the base.

Slope and relief on the PIRA varies from flat to gently sloping plains interspersed with broad domes and, in a few places, more resistant hills that rise sharply above the surrounding plains. Slopes range from zero percent near Rogers Dry Lake to greater than 30 percent near Kramer Hills.

3.5.1.2 Geology

The geologic setting in the vicinity of Edwards AFB, which is located in the western Mojave Desert region, is characterized by three major rock types or geologic complexes: a basement complex of igneous and metamorphic rocks, an intermediate complex of continental volcanic and sedimentary rocks, and valley fill deposits. The basement complex is of pre-Tertiary age and includes quartz monzonite, granite, gneiss, schist, and other igneous and metamorphic rocks. These rocks crop out in the highlands surrounding the playa areas and occur beneath the unconsolidated deposits of the playa. The intermediate complex, with limited exposure in the Edwards AFB vicinity, is of Tertiary age and includes a variety of sedimentary and volcanic rock types (Dutcher and Worts 1963).

3.5.1.3 Soils

The U.S. Department of Agriculture (USDA) Natural Resource Conservation Service has completed a soil survey of Edwards AFB for the U.S. Army Corps of Engineers (USACE). The *Grazing and Cropland Management Plan* for Edwards AFB describes results of this soil survey (USACE 1997). Based on this survey, the soils at Edwards AFB and in Region 1 can be characterized as predominantly alkaline, consisting of loams, sandy loams, and loamy sands, all of which are susceptible to wind and water erosion. Soil pH values range from 7 to 8 for most soils and greater than 8 on lakebed soils. Plant growth is inhibited by the high salinity and exchangeable sodium ion content of some soils, particularly soils in the lakebed basins (Edwards AFB 2002).

The *Grazing and Cropland Management Plan* (USACE 1997) identified five groups of landforms based on soil types that range from playas at the lowest elevation to hills and rock pediments. These landforms are described briefly below.

- Dry lakebeds, including Rogers Dry Lakebed, are most often covered by about 95 percent Wherry soils. These soils are deep and poorly drained, with a clay texture and slopes of 0 to 1 percent. The soil is barren with high saline and sodic content, and is subject to flooding.

- Alluvial fans in the areas surrounding the dry lakes are composed primarily of Leuhman, Norob, and Voyager soils. These soils are deep and moderately well to well drained with slopes of 0 to 5 percent. Textures are of fine sand to clay loam. The soils are saline and sodic, and subject to flooding and wind erosion.

- Dunes and sand sheets around the dry lakes are an intermediate form between the alluvial flats and the fan piedmonts. Cajon soils are dominant with smaller proportions of Challenger and other soils. Soils are deep, moderately well drained to excessively drained sands to loamy sands with slopes from 0 to 15 percent. They are subject to wind erosion.

- Fan piedmonts contain mostly Helendale soil, with smaller portions of Destazo, Lavic, Helendale Taxadjunct, and Cajon soils. These soils are deep, moderately well to well drained, loamy coarse sands to fine sandy loams. Slopes range from 0 to 9 percent. The soils are subject to occasional flooding and wind erosion.

- Rock pediments and hills consist of Randsburg, Hi Vista, Machone, Muroc, and Sparkhule soils, interspersed with rock outcrops. These soils can be very shallow to moderately deep and are well drained, with textures of sandy loam and gravel. Slopes range from 2 to 50 percent. These soils are subject to water and wind erosion.

Alluvial sediments that surround scattered, topographically higher outcrops of granitic rock dominate the surface of Edwards AFB.

3.5.1.4 Erosion

According to the *Soil Survey of Edwards Air Force Base, California, Interim Report* (USDA, Soil Conservation Service 1998) the soils at Edwards AFB are given erosion hazard ratings of slight to severe for wind erosion and slight to moderate for water erosion.

3.5.1.5 Seismicity

Like much of Southern California, Edwards AFB is subject to earthquake activity and associated seismic hazards. At least eight minor faults are known, or are suspected because of their trends, to be present within the boundaries of Edwards AFB; however, no fault has been active in the last 11,000 years.

The geologic and structural development of the vicinity surrounding Edwards AFB has been measurably affected by tectonic activity. The Mojave Structural Block is wedged between two major intersecting shear zones: the northeast-trending Garlock Fault, which controls the trend of the Tehachapi Mountains to the northwest of Edwards AFB, and the northwest-trending San Andreas Fault system, which bounds the San Gabriel Mountains to the south. Both fault zones have had substantial activity in the Quaternary period. The San Andreas Fault zone is the more dominant of the two, with a known length of about 600 miles and right-lateral displacement of up to 350 miles. The Garlock Fault zone is traceable for more than 150 miles and has left-lateral displacement (Weston 1986).

Few earthquakes have been recorded within the triangular area formed between the San Andreas and Garlock Faults that includes Edwards AFB (U.S. Geological Survey [USGS] 1988). Of these, just four have been recorded with epicenters within or near the Base boundary, and all had Richter magnitudes less than 4.4. Another earthquake (magnitude between 4.5 and 6.4) occurred at Bissell, approximately 2 miles northwest of the Base. The intensity of these events on Edwards AFB is unknown. Seismic activity in the Antelope Valley is most prevalent along, and northwest of, the Garlock Fault and along, and southwest of, the San Andreas Fault (AFFTC 1997d).

The San Andreas Fault lies approximately 28 miles southwest of the Main Base on Edwards AFB, trending southeast-northwest on the west side of Palmdale, California. The Garlock Fault lies approximately 20 miles northwest of the Main Base. It has a southwest-northeast trend and meets the San Andreas Fault 60 miles west of the Base. These are major active faults with evidence of Holocene (last 30,000 years) movement (AFFTC 1994, 1997d).

3.5.2 Geology and Soils—Region 2

This section provides a brief description of the topography, geology, and soils for Region 2 and the land underlying the R-2508 Complex. Table 3-8 lists the ecosystem provinces and sections that are under the R-2508 Complex. This classification system is based on the National Hierarchical Framework of Ecological Units (U.S. Forest Service 2004).

The Mojave Desert section of the American Semi-Desert and Desert Province covers portions of San Bernardino, Kern, and Inyo counties that are under the complex and also extends into southern Nevada. The Mojave was once part of the Basin and Range Province and shares its history possibly through the first part of the Miocene. Elevations range from 280 feet below sea level to 4,000 feet above MSL in the valleys and basins, with some mountain ranges reaching as high as 11,000 feet. The mountains rise abruptly from outwash aprons and alluvial fans. Near the bases of some mountains, gravel or bare rock covers the ground. Little soil accumulates on the steep slopes due to erosion from heavy desert rainstorms. Entisols (weakly developed soils developed in unconsolidated parent material with usually no genetic horizons except an A horizon) occur on terraces, older alluvial fans, and better drained basins. The rest of the province is dominated by aridosols (calcium carbonate-containing soils of arid regions that exhibit at least some subsurface horizon development) (U.S. Forest Service 2004).

Table 3-8

Ecosystem Provinces and Sections Underlying the R-2508 Complex and Region 2

Province	Section	County and State	Areas of the R-2508 Complex
American Semi-Desert and Desert	Mojave Desert	San Bernardino, Kern, Inyo, CA; Esmeralda, NV	R-2515, R-2524, R2502, R-2506, R-2505, Panamint, and portions of the Saline, Owens, and Isabella Areas
Sierran Steppe-Mixed Forest-Coniferous Forest-Alpine Meadow Province	Sierra Nevada Foothills Sierra Nevada	Kern, Tulare, Fresno, and Inyo, CA	Portions of the Bishop, Owens, Porterville, and Isabella Areas
Intermountain Semi-Desert and Desert Province	Lahontan Basin	Inyo, CA	Most of Bishop and portions of the Owens and Saline Areas

Source: 95 ABW and AFFTC 2005.

The western portion of the Mojave Desert and the area immediately surrounding the base is dominated by the Antelope Valley, which is bordered to the south by the San Gabriel Mountains, to the northwest by the Tehachapi Mountains, and to the east by low hills. Layers of eroded material from the surrounding mountains have built up over bedrock to form alluvial fans. These layers of rock, sand, and alluvium are shallow along the base of the mountains, rock outcroppings, and butte formations and become deep in the dry lakes or playas. Rock outcroppings, ranging from small, single rocks to small mountains or ridge formations, spot the ground surface (NASA 1997b).

The highest general elevation of the Mojave Desert approaches 4,000 feet but most valleys lie between 2,000 and 4,000 feet. The valleys in the Mojave are proportionally broader and mountains are more widely spaced and do not stand as high as in the Basin and Range (Norris and Webb 1990).

The California portion of the Basin and Range Province includes almost all of Inyo county plus northeastern Kern and northern San Bernardino counties. It extends across Nevada and into Utah. The Great Basin province is characterized by north- and northwest-trending mountain ranges (many in Nevada trend north or northeast), which alternate with intervening basins and valleys (Oakeshott 1978). The valleys are sediment-laden, down-dropped fault blocks. Geologic features include the Shoshone Mountains, Toiyabe Range, and the Big Smoky Valley.

The Sierran Steppe-Mixed Forest-Coniferous Forest-Alpine Meadow Province covers a portion of Kern County and extends into Tulare County and the eastern portion of Fresno County. It also extends along the westernmost edge of Inyo County. The province underlies portions of the Bishop, Owens, Porterville, and Isabella Areas of the R-2508 Complex. The slope of the Sierra Nevada rises gradually from 2,000 feet to more than 14,000 feet; the east slope drops abruptly to the floor of the Great Basin, about 4,000 feet. Much of the region has been glaciated. Ultisols (strongly leached, acid forest soils with relatively low native fertility) are extensive on mountain slopes where air is humid and dry alfisols (moderately leached forest soils that have relatively high native fertility) predominate at lower elevations. Entisols characterize soils occupying the narrow floodplains and alluvial fans of the valleys (U.S. Forest Service 2004).

The Intermountain Semi-Desert and Desert Province covers the physiographic section called the Great Basin. This province covers most of Bishop and portions of the Owens and Saline Areas. The lower parts of many basins have heavy accumulations of saline and alkaline soils. Mountains rise steeply from semiarid, sagebrush-covered plains, and upper elevations bear sparse coniferous forests. Aridisols are dominant in all basin and low-lying areas. Salt flats and playas are extensive in the lower parts of basins with interior drainage. Forest soils are found at high elevations, and narrow bands of entisols lie in the rocky landscapes and stream floodplains (U.S. Forest Service 2004).

3.6 HAZARDOUS WASTE/HAZARDOUS MATERIALS

For purposes of this analysis, the terms “hazardous material” and “hazardous waste” are those substances defined by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Resource Conservation and Recovery Act (RCRA).

A hazardous material is any material whose physical, chemical, or biological characteristics, quantity, or concentration may cause or contribute to adverse effects in organisms or their offspring; pose a substantial present or future danger to the environment; or result in damage to or loss of equipment, property, or personnel.

Hazardous wastes are substances that have been “abandoned, recycled, or are inherently waste like,” and that (because of their quantity, concentration, or characteristics) may cause increases in mortality or serious irreversible illness, or pose a substantial hazard to human health or environment if improperly treated, stored, transported, or disposed of.

Solid waste refers to non-hazardous garbage, refuse, sludge, and any other discarded solid material resulting from residential, commercial, and industrial activities or operations. Solid waste can be classified as construction/demolition waste, non-hazardous recyclable waste, or non-hazardous non-recyclable waste.

3.6.1 Hazardous Materials/Hazardous Waste/Solid Waste—Region 1

The potentially affected hazardous materials, hazardous waste, and solid waste in Region 1 associated with the Proposed Action and Alternatives would be located on Edwards AFB; therefore the discussion on hazardous materials, hazardous waste, and solid waste in Region 1 will be limited to a description of those resources and wastes at Edwards AFB.

3.6.1.1 Hazardous Materials

In Region 1 Edwards AFB uses a wide variety of hazardous materials in support of research activities and mission requirements to support all types of aircraft. Hazardous materials are used for aircraft repair and maintenance, aircraft launch and recovery, AGE repair and maintenance, building remodeling, and construction. Some of the most commonly used hazardous materials include jet and motor fuel, other types of petroleum products, paints, thinners, adhesives, cleaners, lead-acid batteries, hydraulic fluids, and halogenated and non-halogenated solvents (AFFTC 1997d).

Hazardous materials are used to support rocket propulsion research and development at the AFRL. Typical hazardous materials used include liquid and solid rocket propellants, batteries, antifreeze, cleaning/degreasing solvents, and machinery lubricants, which are used in component fabrication, repair, maintenance, and assembly operations (AFFTC 1998a).

Chemical oxygen iodine laser technology uses a chemical reaction for its energy source rather than an electrical power supply. Electrically powered lasers, such as diode-pumped solid state lasers are expected to produce the power levels required for future missions; however, based on current technology, the COIL used by the ABL and ATL programs is the primary system of choice that is capable of developing the megawatt class of laser power. The COIL system designed by Boeing's Rocketdyne Division can be scaled to larger or smaller power levels, as well as larger or smaller chemical capacities.

The typical COIL lasing process begins with an aqueous mixture of hydrogen peroxide and potassium hydroxide, forming a basic hydrogen peroxide (BHP). This solution is produced using commercially available chemicals and water. The BHP is typically mixed only a few hours prior to the mission, since it must be kept cold to prevent rapid decomposition. The BHP is combined with chlorine gas in the laser system, which produces a singlet oxygen, the energy reservoir for the system. Iodine is introduced into the system as a solid, where it is vaporized when combined with hot nitrogen gas. The product/oxygen gas is drawn through the nozzle into the laser cavity where it mixes with a supersonic stream of mixed nitrogen and iodine gas. This mixture creates the laser gain medium, and the chemical is converted to optical energy by stimulated emission between the resonator mirrors. A portion of this optical energy is extracted as the output beam which is emitted as near IR radiation at 1.315 μm. Approximate quantities of chemicals on mission aircraft are shown in Table 3-9 (U.S. Air Force 1997).

Table 3-9

Approximate Quantities of Hazardous Chemicals On-Board Mission Aircraft

Chemical	Quantity (pounds)
Ammonia	1,800
Basic hydrogen peroxide (BHP)	10,000
Chlorine	1,500
Helium	1,000
Nitrogen	500
Iodine	100
Jet fuel for laser devices	1,370

Source: U.S. Air Force 1997.

Typical chemical quantities stored at Edwards AFB for ABL support are shown in Table 3-10. These chemicals are stored, handled, and mixed at the Integrated Maintenance Facility (IMF), where the chemicals for the ABL are currently mixed. This hazardous waste storage facility is situated in a remote area of Edwards AFB approximately 1.2 miles from Building 151 (AFCEE 2003).

Other laser systems associated with the COIL on the ABL include the beacon illuminator laser (BILL), track illuminator laser (TILL), surrogate high energy laser (SHEL), and active ranging system (ARS) laser. These other laser systems are not COIL lasers and use different chemicals to produce their laser beams. They are described in the *Final Environmental Impact Statement for the Program Definition and Risk Reduction Phase of the Airborne Laser Program* (U.S. Air Force 1997) and *Supplemental*

Environmental Impact Statement for the Airborne Laser Program (AFCEE 2003). Basically, these other laser systems pass information that ensures the COIL laser points to, tracks, and fires at the intended target.

Table 3-10

Hazardous Chemicals Used to Support the COIL

Chemical Compound	Maximum Quantity
Ammonia (anhydrous)	4,000 pounds
Basic hydrogen peroxide (BHP) (batch mix)	1,200 gallons
Chlorine	2,000 pounds
Helium	3,000 pounds
Hydrogen peroxide (50 percent concentration)	8,000 gallons
Hydrogen peroxide (70 percent concentration)	4,000 gallons
Iodine	100 pounds
Lithium hydroxide (monohydrate)	6,600 pounds
Liquid carbon dioxide	64,000 pounds
Liquid nitrogen	6,000 gallons
Phosphoric acid	8,500 gallons
Potassium hydroxide (50 percent concentration)	1,200 gallons
Sodium hydroxide (50 percent concentration)	1,200 gallons
Sodium hydroxide (20 percent concentration)	1,700 gallons
Sodium hydroxide (10 percent concentration)	3,360 gallons
Sulfuric acid (93 percent concentration)	660 gallons
Sulfuric acid (25 percent concentration)	2,900 gallons

Source: Air Force Center for Environmental Excellence 2003

The BILL uses water as a coolant, thus producing no hazardous waste during the lasing process. The TILL uses deuterium oxide as a coolant. Deuterium oxide contains more deuterium atoms than ordinary hydrogen atoms (as found in water), thus creating heavy water. There is no regulated maximum contaminant level established by the U.S. EPA for deuterium oxide. These coolants are in closed-loop systems and are only replaced during general maintenance of the systems. The ARS is a carbon dioxide laser that uses Refrigerant 404 in its cooling system. The carbon dioxide laser uses several inert gases such as helium and nitrogen to increase operating efficiency and carbon dioxide as the prominent lasing medium. Deuterated hydrogen peroxide may be used instead of hydrogen peroxide to produce the BHP for the COIL.

The types of hazardous materials most commonly used during construction projects include acids, corrosives, caustics, glycol, compressed gases, paints and paint thinners, solvents, sealant, adhesives, cements, caulking, fire retardant, and hot asphalt (140° F or greater). Building and facility maintenance requires the use of heating fuels, paints, aerosols, and fluorescent light bulbs, all of which are hazardous materials.

Implementation of the Hazardous Materials Pharmacy approach accomplishes several important management goals, including reducing the volume of hazardous materials purchased and hazardous wastes generated through improved materials management. Edwards AFB uses the pharmacy concept to issue hazardous materials for use by Air Force personnel and its contractors. The Hazardous Materials Pharmacy monitors shelf life and tracks usage of hazardous materials. One common database is used to manage issued hazardous material products. Hazardous materials purchased through the pharmacy are bar code labeled upon their arrival at Supply Central Receiving and distributed to the various satellite issue points or Hazardous Materials Distribution Support Centers located throughout Edwards AFB.

All organizations and contractors are required to maintain strict inventories of all their hazardous materials. Furthermore, organizations are also required to reduce the quantity of hazardous materials used or to replace them with non-hazardous material, if possible, as a part of the Pollution Prevention Program. Guidelines used by Edwards AFB include Air Force Instruction (AFI) 32-7086*, Hazardous Materials Management*; AFI 32-7042*, Solid and Hazardous Waste Compliance*; and AFFTC Instruction 32-19*, Hazardous Material Management Process.*

3.6.1.2 Hazardous Waste

Hazardous materials/waste recycling is addressed in Title 22 California Code of Regulations (CCR) 66266.1–66266.130, Assembly Bill 3474, and the California Health and Safety Code, Section 26143.2. This includes commercial chemical products, used or contaminated solvents (halogenated, oxygenated, hydrocarbon), used or unused petroleum products, pickling liquor, unspent acids, unspent alkalis, and unrinsed empty containers of iron or steel used for pesticides or other hazardous chemicals.

The use of hazardous materials results in generation of hazardous waste (e.g., paint waste, used oil, contaminated rags), which requires proper handling. The U.S. EPA enforces the RCRA (40 CFR 260–272), which provides guidelines for the generation, storage, transportation, and disposal of hazardous waste. The California Environmental Protection Agency (Cal/EPA) enforces hazardous waste laws embodied in 22 CCR Chapters 10–20 and the California Health and Safety Code (Section 25100). Environmental Management at Edwards AFB manages hazardous waste accumulation. Guidelines used by Edwards AFB include the *Edwards Air Force Base Hazardous Waste Management Plan* (AFFTC 1998a), which was prepared in accordance with AFI 32-7042*, Solid and Hazardous Waste Compliance*.

It establishes procedures to achieve compliance with applicable federal, state, and local regulations for hazardous waste management, except munitions, explosives, biohazards, and radioactive waste. Specifically, it contains requirements for solid and hazardous waste characterization, training, accumulation, turn-in, and disposal, as well as procedures for inspections, permits, and record keeping.

Currently, by-products generated by the COIL from ground laser tests by the ABL are vented through the pressure recovery system to simulate airborne release. These by-products are captured by the pressure recovery system. The typical airborne COIL creates the hazardous and non-hazardous waste by-products listed in Table 3-11.

Table 3-11

Waste Created During a Typical Mission

Chemical	Quantity (pounds)
Basic hydrogen peroxide (BHP) (batch mix)	2,000[1]
Potassium chloride (KCl)	X[1]
Potassium hydroxide (KOH)	X[1]
Chlorine (Cl_2)	20
Iodine (I_2)	1[1]
Gaseous nitrogen (GN_2)	60
Liquid nitrogen (N_2)	400
Zeolite (clay)[2]	500

Notes: 1 – Trace amounts of BHP containing potassium chloride and potassium hydroxide may be carried with the gas stream (containing iodine) into the zeolite.
2 – Zeolite (clay) is a solid waste, not a hazardous waste.

Source: Nonlethal Environmental Evaluation and Remediation Center 2003.

Waste products are removed from the aircraft after the mission and before fresh fluids are introduced. The wastewater from laser testing is processed through a series of three 20,000-gallon baker tanks where hazardous constituents are neutralized. The non-hazardous industrial wastewater is then characterized to determine if it can be:

- Released into the sanitary sewer;
- Sent directly to one of the five WWTP evaporation ponds on Edwards AFB;
- Transported to an off-site disposal facility; or
- Sold and used as a co-product to produce a solidification agent or other products.

Other hazardous waste by-products are managed at the point of generation. These hazardous wastes are stored at an initial accumulation point at or near the point of generation and then sent to a 90-day accumulation point or to the Conforming Storage Facility where the wastes are managed and disposed of according to state and federal guidelines.

Other types of laser systems that would be similar to those undergoing test and evaluation at Edwards AFB could include chemical lasers like the deuterium fluoride or hydrogen fluoride lasers and diode-pumped solid state lasers like the YAG or Nd:YAG laser.

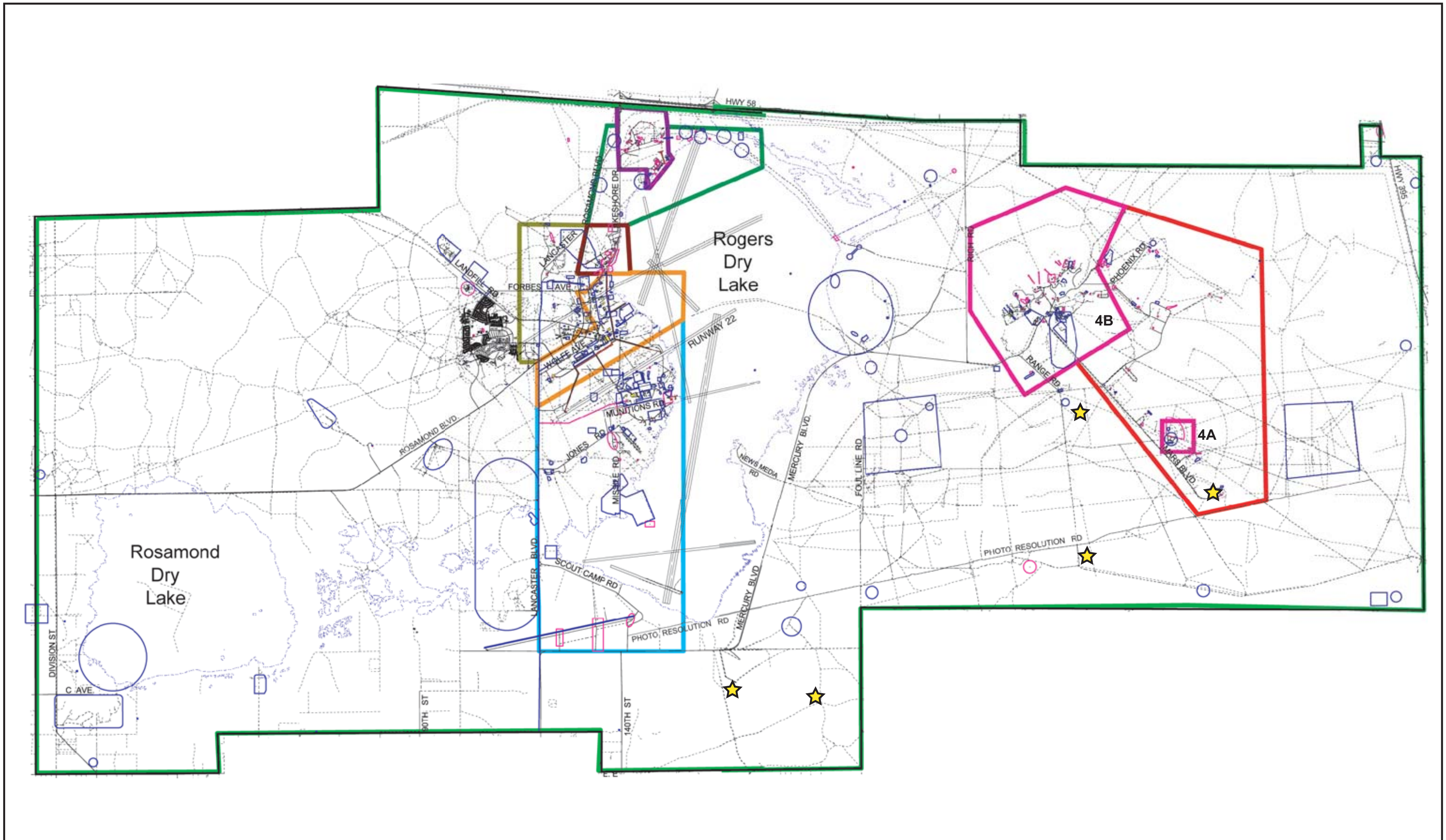
Geologic resources (i.e., soil and groundwater) are susceptible to contamination from the surface. Releases of hazardous chemicals such as petroleum products and solvents have resulted in soil contamination at military installations. Contaminated soil or groundwater may require physical removal or extensive remediation to ensure the protection of public health and safety.

The Installation Restoration Program (IRP) was established to identify, investigate, assess, and clean up hazardous waste at former disposal sites on the base in compliance with CERCLA. Under the IRP, a Preliminary Assessment was conducted at Edwards AFB to locate potential areas of concern that may have resulted from past activities on the 301,000-acre base.

Edwards AFB has identified 471 IRP sites and areas of concern with potential contamination. The IRP sites at Edwards AFB are grouped into 10 Operable Units (OUs), generally based on geographic location. IRP sites, areas of concern, and OUs are shown in Figure 3-9. Runway 22 lies within OU 2, and several IRP sites are located adjacent to the runway.

3.6.1.3 Solid Waste

Edwards AFB operates a non-hazardous (municipal solid) waste landfill within the Main Base area. At current disposal rates, the landfill is expected to reach permitted capacity in 2019. Due to the volume of construction/demolition waste generated by Edwards AFB, most current construction contracts require the contractor to dispose of such wastes at an approved landfill outside of Edwards AFB in order to reduce the impacts to the Main Base Landfill. Flight test–related solid waste would include aircraft parts made of metal, plastic, rubber, composites, and other alloys. These solid wastes would be managed per current solid waste management directives and instructions. Edwards AFB actively participates in a recycling program, which is operated by a contractor with program oversight provided by 95 ABW/CEV Environmental Management. Some waste metals generated during construction and demolition projects,



LEGEND

- Unpaved Roads
- Paved Roads
- Stream and Lakes
- Taxiways
- Base Boundary
- Buildings
- Area of Concern
- IRP Site

OPERABLE UNITS (OUs)

- OU 1
- OU 2
- OU 3
- OU 4A
- OU 4B
- OU 5
- OU 6
- OU 7
- OU 8
- OU 9
- OU 10

N

0 2 4 6
SCALE IN STATUTE MILES

LTAs (not to scale; locations are approximations)

EA FOR THE TESTING AND EVALUATION OF DIRECTED ENERGY SYSTEMS USING LASER TECHNOLOGY AT EDWARDS AFB

Sites, Areas of Concern, and Operable Units at Edwards AFB

TC#	DATE	DRAWN BY	FILENAME	FIGURE NO.
Q242-03	1/10/05	Knight	Fig3-09.ai	3-9

as well as the routine operations of various base organizations, are diverted to the Defense Reutilization and Marketing Office for resale.

3.6.2 Hazardous Materials/Hazardous Waste/Solid Waste—Region 2

Hazardous materials, hazardous waste, and solid waste in Region 2 are similar to those used and created in Region 1. Similar to hazardous material management practices at Edwards AFB, hazardous material management in other areas of Region 2 includes the purchase, storage, and distribution of hazardous materials such as paints, solvents, lubricants, batteries, and other substances containing chemicals that are potentially harmful to the affected environment. These wastes must be containerized, labeled, stored, and transported in accordance with U.S. EPA and state requirements. In California, the Department of Toxic Substances Control (DTSC) administers most aspects of RCRA directly. In 1997, the DTSC delegated oversight of hazardous waste generation to the local Certified Unified Program Agencies. The California Hazardous Waste Control Law provides a separate regulatory framework for hazardous waste management within the state. This state framework incorporates all federal RCRA requirements as well as many stricter state standards. There are hundreds of hazardous waste generators (e.g., businesses, schools, state facilities, and other DoD facilities) in Region 2. Solid waste management activities are monitored by the California Integrated Waste Management Board.

3.7 INFRASTRUCTURE

Infrastructure refers to the physical components that are used to deliver something (e.g., electricity, traffic) to the point of use. Elements of infrastructure typically include energy, water, wastewater, electricity, natural gas, liquid fuel distribution systems, communication lines (e.g., telephone, computer), and circulation systems (streets and railroads).

3.7.1 Infrastructure—Region 1

3.7.1.1 Energy Resources

The general policy of the Air Force regarding energy is as follows:

> Energy is essential to the Air Force's capability to maintain peacetime training, readiness, and credible deterrence; to provide quality of life; and to perform and sustain wartime operations. In short, energy is an integral part of the weapon system. The most fundamental Air Force energy policy goal is to ensure energy support to the national

> security mission of the Air Force in a manner that emphasizes efficiency of use, effectiveness of costs, and independence from foreign sources for mission-essential operations… (AFFTC 1995).

Edwards AFB uses electricity, solar power (e.g., photovoltaic panels to run traffic lights and heat water), and natural gas/propane and other petroleum-based products (gasoline, jet fuel, and diesel) as sources of energy to operate facilities, vehicles, equipment, and aircraft.

Southern California Edison provides electricity to Edwards AFB. The base uses this energy source to operate a variety of systems including lighting, heating and cooling, computers, and pumps for gas and water. Pacific Gas and Electric supplies natural gas to Edwards AFB. The base uses natural gas to run boilers, furnaces, and two standby generators. Propane is used in areas where natural gas services are unavailable and is used to operate one standby generator. Edwards AFB uses solar energy for hot water and forced air heating systems; to provide light (i.e., skylights); and to operate the emergency phone system on major portions of Rosamond, Lancaster, and Mercury Boulevards.

Edwards AFB is responsible for approximately 13.4 miles of petroleum pipeline used to transport jet fuel to various locations throughout the base. The supply pipeline for the base is the CalNev Pipeline. Edwards AFB receives jet fuel from a spur line from the George AFB terminal.

3.7.1.2 Water Distribution System

The AFFTC purchases potable water from the Antelope Valley East Kern (AVEK) Water Agency. This water is distributed through a system located in Boron, California. The water distribution system for Edwards AFB consists of a series of pipes ranging in size from 4 to 24 inches in diameter, booster pump stations, and storage tanks. Five storage tanks, three at the Main Family Housing area and two at North Base, provide a potable water storage capacity of 4.3 million gallons. Additional storage tanks dedicated to fire suppression are located throughout the base. The distribution system, although presently adequate, requires continuous repairs and replacement to sustain its capacity (AFFTC 1997a).

3.7.1.3 Wastewater/Storm Water

There are two sanitary sewer collection and treatment systems on Edwards AFB. These systems service the Main, North, and South Base areas and the AFRL. The collection network for the existing system is composed of gravity lines, force mains, and pump stations. The Main Base Waste Water Treatment Plant (WWTP) provides tertiary treatment of wastewater. The facility consists of headworks and a solids-removal filter, flowmeter, aerator system, and five 50+ acre evaporation ponds. The WWTP operates under Board Order No. 6-94-52 of the California Regional Water Quality Control Board, Lahontan District. The WWTP treats 100 percent of the wastewater from the sanitary sewer systems on Main, North, and South Bases. The plant is designed to collect, treat, and dispose of an average flow of 2.5 million gallons per day (mgd) of influent, and has a design peak of 4 mgd. The facility is designed to produce tertiary treated effluent that will be used to supplement landscape irrigation at locations such as the golf course. The irrigation system is designed to dispose of 2.5 mgd. Only the amount of effluent that cannot be used for landscape irrigation will be diverted to the evaporation ponds. The receiving waters are the groundwaters of the Lancaster Subarea of the Antelope Hydrologic Unit (AFFTC 2000).

The storm water distribution system at Edwards AFB consists of conveyance structures and drainage ditches (unpaved). Storm water conveyance structures include channels, gutters, drains, and sewers (not tied into the sanitary sewer system) that collect storm water runoff and direct its flow. The storm water system at Main Base conveys storm water to a pretreatment facility, which consists of an oil-water separator and an evaporation pond (AFFTC 1998b). Storm water from the undeveloped portions of the base flows into the nearest dry lake (AFFTC 1994).

3.7.1.4 Communication Systems

Communication systems on Edwards AFB include telephone, microwave, and local area networks. The distribution system for these networks generally consists of copper-pair cable, fiber-optic cable, and a communication manhole/conduit system.

3.7.1.5 Transportation Systems

Edwards AFB is accessed by way of Rosamond Boulevard from the west or north, and by Lancaster Boulevard/120th Street East from the south. Primary access to Edwards AFB from the adjacent roadways is by way of North Gate, West Gate, and South Gate, each of which is in operation 24 hours a day, 7 days a week. All gates contain two inbound and two outbound lanes (USACE 1994; USACE and AFFTC 1994).

Internal circulation on base is by way of paved and unpaved primary, secondary, and tertiary roads. Primary roads connect Edwards AFB components such as the flightline, Engineering and Administration, and support areas to entry points. Secondary roads connect Edwards AFB components to one another and support facilities such as commercial or housing areas. Tertiary roads are unpaved access roads or residential streets within the housing area (AFFTC 1997b).

The primary base streets currently carry all rush-hour traffic without significant congestion problems. The traffic flow at the West Gate is approximately 5,300 vehicles daily or 40 percent of total base traffic volume. The South Gate has a traffic flow of approximately 4,600 vehicles daily or 34 percent of the total base traffic volume. The North Gate services approximately 3,500 vehicles daily or 26 percent of the total. The West Gate provides the best free flow during morning rush-hour traffic, while the South and North Gates allow sufficient flow without exceeding design capacity.

Traffic consists of government, contractor, and privately owned vehicles belonging to those who live and/or work on base. In addition, commercial vehicles deliver material to businesses and facilities in the area. Commercial and Air Force vehicles are used for service and construction work done in the area. Emergency vehicles require access to all buildings and roads. In addition to the paved roadways, an extensive network of unimproved dirt roadways exists, essentially equivalent to the paved network. These roads have posted speed limits and provide access to various installation facilities and sites.

Two railroads are adjacent to the base. The Southern Pacific line runs parallel to the base's west boundary and adjacent to Sierra Highway. The north/south main line does not provide service to Edwards AFB. The Atchison, Topeka, and Santa Fe Railroad is located south of California Highway 58 and along the northern boundary of the Base. Two rail spurs, one at Edwards Station and the other at Boron Station connect to the Main Base and AFRL, respectively (AFFTC 1994).

3.7.2 Infrastructure—Region 2

Areas beneath the R-2508 Complex in Region 2 sustain widespread infrastructure, including traffic circulation systems such as highways and byways, unpaved roads, non-maintained roads, railroad lines, and other systems involved in mass transportation. Hundreds of miles of road and railroad traverse the land beneath the R-2508 Complex. Major highways under the R-2508 Complex include State Highways 14, 58, 127, 136, 168, 178, and 190 and Federal Highway 395.

The R-2508 Complex, which encompasses the Region 2 ROI for Alternatives A, B, and C, was selected because only a few rural communities with low population densities would be located under it. The associated infrastructure includes rural distribution systems for telephone, electricity, and natural gas/liquid fuels. Water treatment and waste management facilities supporting these rural communities are also located under the R-2508 Complex.

In addition, pipelines for crude oil transportation are operated by Chevron, ExxonMobil, Shell, Texaco, Unocal, ARCO, and Pacific Texas. (Department of Energy 2001).

Figure 3-10 shows the distribution of infrastructure within the area under the R-2508 Complex.

3.8 LAND USE

The ROI for land use is Region 1 (Edwards AFB) and Region 2 (land within the R-2508 Complex). Land use is described for Edwards AFB and Management Areas A through G, focusing on examples of LTAs mentioned in Section 2.0 and depicted in Figure 2-4. This section also describes land uses under the R-2508 Complex. Included is a brief description of the visual and aesthetic resources within the ROI.

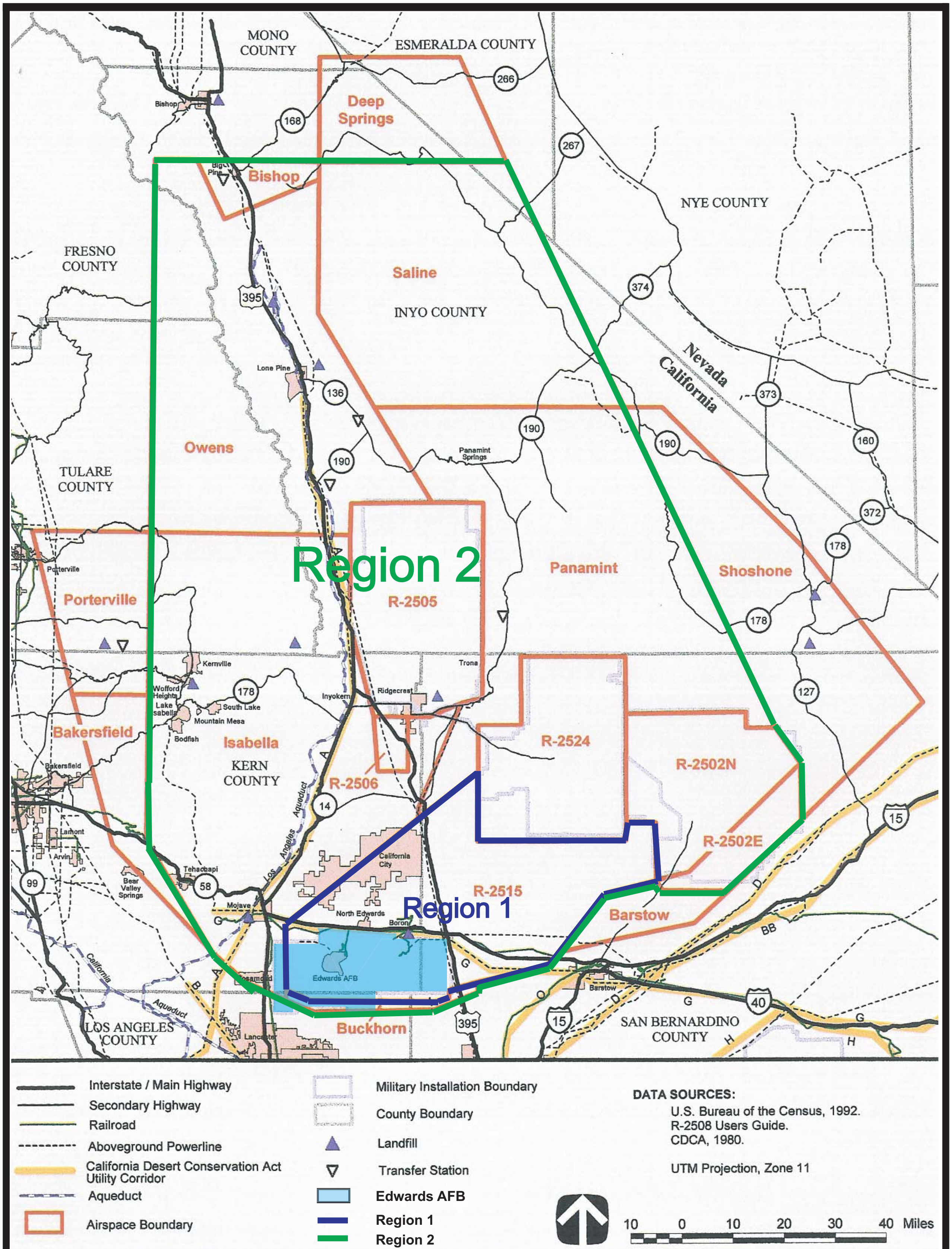
3.8.1 Land Use—Region 1

Edwards AFB is situated in Kern, Los Angeles, and San Bernardino Counties, approximately 60 miles northeast of the city of Los Angeles. The base lands are classified and managed using three land categories of improved, semi-improved, and unimproved. Approximately 290,957 acres of largely undeveloped or semi-improved land are used to support flight-testing of a wide variety of military, civilian, and experimental aircraft. Unimproved lands comprise 95.3 percent of total base lands; semi-improved lands account for about 1.5 percent of the total, and improved land accounts for about 3.2 percent.

Semi-improved lands include areas that are generally located in proximity to airfields, runways, test facilities, parking ramps, fence lines, some recreational areas, and relatively undeveloped areas such as open storage areas (Edwards AFB 2002).

The developed portion of the base is concentrated on the west side of Rogers Dry Lake. It includes clear areas around test facilities and improved runways (Edwards AFB 2002). Developed areas include Main Base, North Base, South Base, Family Housing areas, and the AFRL. The *Edwards Air Force Base Comprehensive Plan* describes long-range development for Edwards AFB, establishing goals, policies, plans, and anticipated action regarding the physical, social, and economic environment (AFFTC 1994).

Land use designations, including total acreage and percent of the base area, are described in Table 3-12 (AFFTC 1994).



Infrastructure Within Regions 1 and 2	Figure 3-10	Q242-04	1/06/05

Within these various land use categories, specific areas have been designated for a particular purpose. These include, but are not limited to, the off-road vehicle areas I and II, the Combat Arms Range, hunting and fishing areas, the PIRA, and the AFRL.

A portion of Edwards AFB is designated for the NASA Dryden Flight Research Center (DFRC), which is a major installation on Edwards AFB, covering 838 acres. DFRC's existing land-use plan divides its facility into three basic use zones: (1) the flightline, (2) support services, and (3) explosive hazard zones. The flightline zone is adjacent to Rogers Dry Lake, is restricted to flight research activities, and includes aircraft hangars, test facilities, pavement, and runways. Support services are behind the flightline zone and include warehouses, project support complexes, and administrative support. Western Aeronautical Test Range zones include a remote site and a small triangular section of the facility adjacent to Lily Avenue that includes a radio tower. The remote site includes the facility's water tower and several radio towers. The two explosive hazard zones overlap the flightline and support services zone. These two circular zones extend for a minimum distance of 1,200 feet from the shuttle loading area (NASA 1999).

Table 3-12

Land Use Designations in Region 1 (Edwards AFB)

Land Use Designation	Total Square Miles	Total Acres	Percentage of Total Base Property
Aircraft Clearance, Quantity-Distance	4.86	3,110.40	1.00
Aircraft Pavement, Runways	0.91	582.40	0.20
Lakebed Painted Runways	3.12	1,996.80	0.070
Lakebed Non-maintained Landing Site	61.00	39,040.00	13.00
Aircraft Operations and Maintenance	0.2	128	0.04
Engineering Test	27.83	17,811.20	5.90
Aircraft Test Ranges	336.23	215,187.20	71.50
Industrial	12.18	7,795.20	2.60
Administrative	0.19	121.60	0.04
Community Commercial	0.21	134.60	0.04
Community Service	0.30	192.00	0.10
Medical	0.07	44.80	0.01
Housing	1.52	972.80	0.30
Outdoor Recreation	3.83	2,451.20	0.80
Buffer Zone	17.75	11,360.00	3.80
Water	0.00	0.00	0.00
Total[1]	**470**	**300,800**	**100**

Note: 1- Rounded to the nearest whole number.

3.8.1.1 Land Use Restrictions

Air Force land use policies and guidance are only applicable to lands under their control. Policies established by the Air Force for airfields are similar to the criteria established by the FAA for development of surrounding civilian airports. Air Force Joint Manual 32-1013, *Airfield and Heliport Planning and Design Criteria,* sets the minimum requirements for airfields and applicable land uses for surrounding areas. As part of the review and approval process, the Edwards AFB Planning and Zoning Committee grants final siting approval for all construction and activity-related projects.

Edwards AFB has three paved runways that provide the principal landing surfaces for the base. These runways are divided into two different classes: A, and B. The primary difference between class A and B runways is in the type of aircraft that use the runway. Class A runways are primarily intended for small, light aircraft, whereas class B runways are primarily intended for high performance and large, heavy aircraft. The Main Base Runway (Runway 22) is a class B runway and is the primary airstrip. The runways on North and South Base are class A. In addition, the base has 18 runways painted on dry lakebeds and uses the remaining lakebed areas for emergency landings.

Land use controls around airfields and lakebeds are recommended by the air installation compatible use zone (AICUZ). The AICUZ delineates areas at both ends of a runway, called accident potential zones (APZs), where the probability of aircraft accidents is highest based on statistical analysis of past accident data at various bases.

A clear zone is an area on the ground or water extending from the end of the runway and symmetrical about its center. This zone is to be free of obstacles for the safety of approaching aircraft. The clear zone for a class A runway is 1,000 feet wide by 3,000 feet long. The clear zone for a class B runway is 3,000 feet wide by 3,000 feet long.

Accident potential zones I and II, located beyond the clear zone, possess a significant potential for accidents. Each zone has associated land use restrictions, and its size is dependent upon a variety of factors defined in Air Force Joint Manual 32-1013, *Airfield and Heliport Planning and Design Criteria*. The following land uses are generally compatible with APZ 1: industrial, agricultural, recreational, and vacant land. In addition to compatibility with APZ I land uses, APZ II includes low-intensity residential and nonresidential uses for a maximum of 20 percent building coverage per acre.

Explosive hazard or quantity-distance zones are associated with test areas and areas for explosives, munitions, and propellant storage. These zones vary in size depending upon the quantity and type of explosive being used or stored. Zoning ensures the safety of all personnel within a given area. Typical areas where these zones exist include the unconventional fuels area, the explosive ordnance disposal area, the gun-butt and munitions storage area, the arm/de-arm areas, the hot cargo area, the PIRA, and the AFRL.

3.8.1.2 Management Areas A through G

The ROI for the Proposed Action includes the area under the R-2508 Complex, particularly those areas surrounding the proposed LTAs and test facilities such as the BFTF. Ground testing of developmental laser systems would be conducted in established laser testing facilities, such as the BFTF, and from ground stations and mobile vehicles located in positions on Edwards AFB as determined by the test plan. Lasers would be directed over open land to ground targets that would be established near the dry lakebeds, Grinnel, Mt. Mesa, Jackrabbit Hill, and Haystack Butte (Figure 2-4). Testing of aircraft-mounted developmental laser systems would occur within the R-2508 Complex and would involve beaming to targets on any of the Edwards AFB Management Areas A through G (Figure 2-3); however most targets and target areas would be located in Management Area B (PIRA) and Management Area G (AFRL). The test and evaluation programs would use existing facilities and modify buildings on an as-needed basis.

Individual management plans have been developed to ensure the implementation of best management practices when planning and conducting mission activities. A more detailed description of each of the management areas is provided in the base's *Final Integrated Natural Resources Management Plan* (INRMP)(Edwards AFB 2004). A summary of the management areas is provided below.

Management Area A (Aircraft Overflight Test Area)

This management area is generally undeveloped and is used to support aircraft test activity, including a jettison area at the end of the runway for emergency offloading. It extends just northeast of Rogers Dry Lake, and some of the area is used as a buffer zone around Main Base Runway 04/22. Included in the management area are well fields, clay pan playas, and natural and man-made water sources, which are used by wildlife and include Branch Memorial Park Pond and Piute Ponds. These areas also provide for various outdoor recreational uses. Projects in the area are primarily infrastructure improvement and maintenance.

Management Area B (Precision Impact Range Area)

Covering a large portion of the eastern part of Edwards AFB, this management area is used for aircraft flight-testing, explosive ordnance disposal, placement of communication equipment, testing of aircraft targeting equipment, and practice in precision bombing. It is also being considered for the use of high explosives weapons testing. The PIRA supports high desert tortoise densities, sensitive non-listed species, and some of the base's highest quality wildlife habitat. Proposed laser target areas in the PIRA include Grinnel, Mt. Mesa, and Jackrabbit Hill.

Management Area C (Developed Area [Housing/Commercial/Industrial])

The Main Base, North Base, South Base, NASA, and the base landfill are included in this management area. It also contains the runway and airfield support facilities, operations and maintenance, engineering, other industrial use area, and research and development facilities such as the BFTF. Mission activities include aircraft testing, operation, maintenance, site demolition and redevelopment, administrative, medical, educational, and commercial uses. Water resource issues are of concern in this management area. Other environmental concerns include bird/aircraft strike hazard (BASH) management, pest management, desert tortoise protection, and vegetation recovery.

Management Area D (Combat Arms Range)

This management area includes the Combat Arms Range, the Rod and Gun Club, and outdoor recreational areas. The area includes desert tortoise and other protected species, and is located apart from other developed areas and facilities for safety and noise considerations.

Management Area E (Dry Lakebeds [Flight Test/Runways])

The Rogers, Rosamond, and Buckhorn Dry Lakebeds, distinctive features of Edwards AFB, are included in this management area. They will continue to be used to support aircraft and space mission activities. Minimizing ground disturbance and development in the dry lakebeds, especially Rogers Dry Lake, is important in order to minimize impacts to the surface. Maintaining the surface of the dry lakes is critical for aircraft test activities.

Management Area F (Military Exercise/Test Area)

Located in the northwest corner of the base, mission activities within this management area include aircraft testing and a buffer zone for military housing. Subunits in the management area include designated hunting areas and off-road vehicle use areas; the remainder of the area is primarily open space under aircraft test areas. Development in this area will support continued aircraft testing. Future planned projects include airfield (emergency runway) improvement and radar reflector repair. The area is relatively undeveloped and includes desert tortoise and Mohave ground squirrel populations. It also provides good nesting and roosting habitat for bird and bat species.

Management Area G (Air Force Research Laboratory)

This management area is a relatively isolated developed area in the northeastern portion of the base; it is surrounded by undeveloped aircraft test and targeting areas. Mission activities conducted at the laboratory include, but are not limited to, testing rocket engines, extensive safety zones surrounding the test cells, and administrative, industrial, and research and development uses. The area includes Haystack Butte and Leuhman Ridge, which support special wildlife species including the peregrine falcon which is federally listed as protected. Sensitive plant species in this area include Barstow woolly sunflower and Desert cymopterus. Proposed laser ground targets in this area include Haystack Butte and an existing target board (see Figure 2-4). Other potential sites at AFRL would be evaluated prior to use as LTAs or FPs.

3.8.1.3 Airfield Operations

Flightline operations are carried out by the 412th Test Wing (412 TW) and the 95 ABW. The 412 TW is the direct mission organization of the AFFTC, which is responsible for testing and evaluating manned and unmanned aerospace vehicles, subsystems, and components. The 95 ABW is the support unit on Edwards AFB responsible for communications; civil engineering; transportation, including loading and unloading armament and supplies; fuel supply; security police; and fire protection. Testing of aircraft-mounted developmental laser systems would occur within the R-2508 Complex (see Figure 2-2). Atmospheric lasing activities would be performed within the R-2508 Complex upward into the atmosphere toward infinity.

3.8.1.4 Visual/Aesthetic Resources

The Bureau of Land Management (BLM) created the Visual Resource Management Program, which divides the base into four sub-units and rates them according to the following factors: landform, vegetation, water, color, influence of adjacent scenery, scarcity, and cultural modification.

- **Class A.** These areas contain a combination of the most outstanding characteristics of each rating factor. There are no Class A areas on Edwards AFB.

- **Class B.** These areas contain a combination of some outstanding features and features fairly common to the physiographic region. Areas with lakebeds (i.e., Management Area E), the more scenic and relatively undisturbed hills and ridges, the denser Joshua Tree woodlands, and Leuhman Ridge in Management Area G fall into Class B. Class B areas can be found primarily through the central part of the PIRA (Management Area B), from Mercury Boulevard to U.S. Highway 395.

- **Class C.** These areas contain features fairly common to the physiographic region and include the remainder of the base, with the exception of the developed areas. Class C areas can be found primarily along the northern, southern, and southeastern boundaries of the PIRA (Edwards AFB 1996). Landforms on the PIRA consist of claypans, edge playas, flat to rolling terrain, and scattered rugged hills and ridgelines. Unique visual resources on the PIRA include

  - Mount Mesa complex, located on the southwest portion;
  - Jackrabbit Hill and surrounding ridges that mark the southern boundary;
  - Red Buttes, located in the southeast portion;
  - Kramer Hills, on the east boundary; and
  - The flat plains comprising the West, East, and PB-6 Ranges.

- **Class D.** These areas are so heavily developed and/or extensively disturbed that they lack positive aesthetic attributes, thereby diminishing the visual quality of surrounding areas. This category includes several areas in Management Area C such as Main Base, North Base, South Base, NASA, housing, and the AFRL in Management Area G (AFFTC 1994).

The PIRA is relatively devoid of manmade objects with the exception of the graded areas for the West Range and buildings painted white (e.g., AFRL water system, instrumentation and observation buildings). The PIRA contains both Class B and C areas, in approximately equal proportions.

Edwards AFB contains two areas with special ecological concerns: desert tortoise critical habitat, and Significant Ecological Areas (SEAs). These areas are discussed further in Section 3.9, Natural Resources.

3.8.2 Land Use—Region 2

The majority of the information on land use for Region 2 is summarized from the *R-2508 Complex Environmental Baseline Survey* except where indicated (95 ABW and AFFTC 2005). The R-2508 Complex is a major range and test facility located in the western Mojave Desert of Southern California. Much of the land area beneath the R-2508 Complex is protected, the area's permanent population is sparse, and development is scattered.

The Complex is managed by a Joint Policy and Planning Board led by the Commanders of the AFFTC at Edwards AFB, the Naval Air Warfare Center Weapons Division, NAWS China Lake, and Fort Irwin National Training Center (NTC). It overlies portions of Inyo, Fresno, Tulare, Kern, Los Angeles, and San Bernardino counties. Approximately 300 square miles of the Complex overlie Esmeralda County, Nevada. The primary land owners or managers are the DoD, U.S. Forest Service (USFS), U.S. Department of the Interior, National Park Service, and BLM. There are also State of California, Native American, local government, and private lands under the R-2508 Complex.

3.8.2.1 Military Complexes

Land uses in the R-2508 Complex include the military facilities of Edwards AFB, NAWS China Lake, and Fort Irwin NTC. Each of these military installations underlies restricted airspace in the complex: Edwards AFB underlies restricted area R-2515, NAWS China Lake underlies restricted areas R-2505 and R-2524, and Fort Irwin NTC underlies restricted areas R-2502N and R-2502E.

3.8.2.2 Natural Resources

Many of the natural features beneath the airspace are unique and have been given special protection as part of a national park, national forest, state park or other designation. Parkland includes Death Valley National Park, Kings Canyon National Park, Sequoia National Park, and some state parks. Approximately 670 square miles of the Kings Canyon and Sequoia National Parks are under the R-2508 Complex. National forests include the Inyo National Forest and the Sequoia National Forest. Additionally, there are 26 wilderness areas managed by the BLM and USFS under the R-2508 Complex, as well as three designated National Scenic or Recreation Trails.

3.8.2.3 Native American Reservations

The four Native American reservations within Region 2 include the Big Pine Reservation Nation, the Lone Pine Reservation Nation, the Fort Independence Reservation Nation, and the Tule River Reservation Nation. There is also a 40-acre Timbisha Western Shoshone village site at Furnace Creek in Death Valley National Park.

3.8.2.4 City/County Lands

The majority of Region 2 is sparsely developed and most of the cities and towns are located in the Lake Isabella area and along the corridors of U.S. Highway 395 and State Highways 14 and 58. Much of the central portion of the Owens Area is owned by the Los Angeles Department of Water and Power for utility easements. Cities include Boron with a population of 2,025; California City (adjacent to China Lake) with a population 8,385; and Ridgecrest with a population of 24,927 (U.S. Census Bureau 2000). The greatest concentrations of private land occur in the southwest portion of Region 2, essentially from Porterville to Edwards AFB; southwest of China Lake; and in the Owens Valley. Private land uses include residential, agricultural (mostly ranching), and mining.

3.8.2.5 Airports

There are several chartered public use airports and chartered private airports within Region 2 (Refer to Section 3.2, Airspace for detailed information on the airports and airfields beneath the R-2508 Complex).

3.8.2.6 Land Management

Land use planning laws affecting federal land management agency administration of the land under the R-2508 Complex include the Federal Land Policy and Management Act and the California Desert Protection Act. Applicable regional plans include the California Desert Conservation Area Plan, the West Mojave Land Tenure Adjustment, the West Mojave Coordinated Management Plan, and the Northern and Eastern Mojave Planning Effort. Descriptions of these land use planning laws and regional plans are provided in the *R-2508 Complex Environmental Baseline Survey* (95th ABW and AFFTC 2005).

A Memorandum of Understanding has been signed between the AFFTC and the BLM, California Desert District, regarding land use decisions on the 2.8 million acres in the R-2508 Complex that are managed by the California Desert Conservation Area Plan.

3.8.2.7 Visual and Aesthetic Resources

Visual and aesthetic resources beneath the R-2508 Complex include the natural features within Death Valley National Park, Kings Canyon National Park, Sequoia National Park, some state parks, designated wilderness areas, designated wild and scenic rivers (Section 3.14 Water Resources), and the Owens River.

3.9 NATURAL RESOURCES

Biological resources are defined as terrestrial and aquatic ecosystems with the native plants and animals that occur throughout these ecosystems. This includes plant populations and communities; wildlife populations and their relationship to habitat; and aquatic habitat and riparian ecosystems. Plant and animal species that are proposed for, candidates for, or are listed as, threatened or endangered by the U.S. Fish and Wildlife Service (USFWS), and species having equivalent status at the California state level, are referred to as special-status species and are given special consideration by law for their preservation. The ROI for natural resources is Edwards AFB and the R-2508 Complex.

Critical habitat for a threatened and endangered species is defined under the federal Endangered Species Act (ESA) as specific areas within the geographical area occupied by the species at the time it is listed that contain the physical or biological features that are essential to the conservation of the species and may require special management considerations or protection, and specific areas outside the geographic area occupied by the species at the time it is listed that are also essential to the conservation of the species.

The USFWS identifies primary physical and biological constituent elements of an area designated as critical habitat that are essential to the conservation of the species (50 CFR 424.12). Primary constituent elements may include, but are not limited to, roost sites, nesting grounds, spawning sites, feeding sites, seasonal wetlands or drylands, water quality or quantity, host species or plant pollinators, geological formations, vegetation types, tides, and specific soil types (50 CFR 424.12).

Under Section 7 of the ESA consultation with the USFWS is required for federal projects if such actions could directly or indirectly affect listed species or destroy or adversely modify critical habitat; a conference is required if such action could directly or indirectly affect a proposed listed species or proposed critical habitat. The Air Force developed management goals and objectives as specified in the INRMP as required by the Sikes Act. This INRMP provides guidance for protecting sensitive species, sensitive communities, and habitats recognized by state and local agencies when evaluating impacts of a project.

3.9.1 Natural Resources–Region 1

The potentially affected natural resources in Region 1 associated with the Proposed Action and Alternatives are located on Edwards AFB; therefore the discussion on natural resources in Region 1 will be limited to a description of those resources on Edwards AFB.

3.9.1.1 Plants

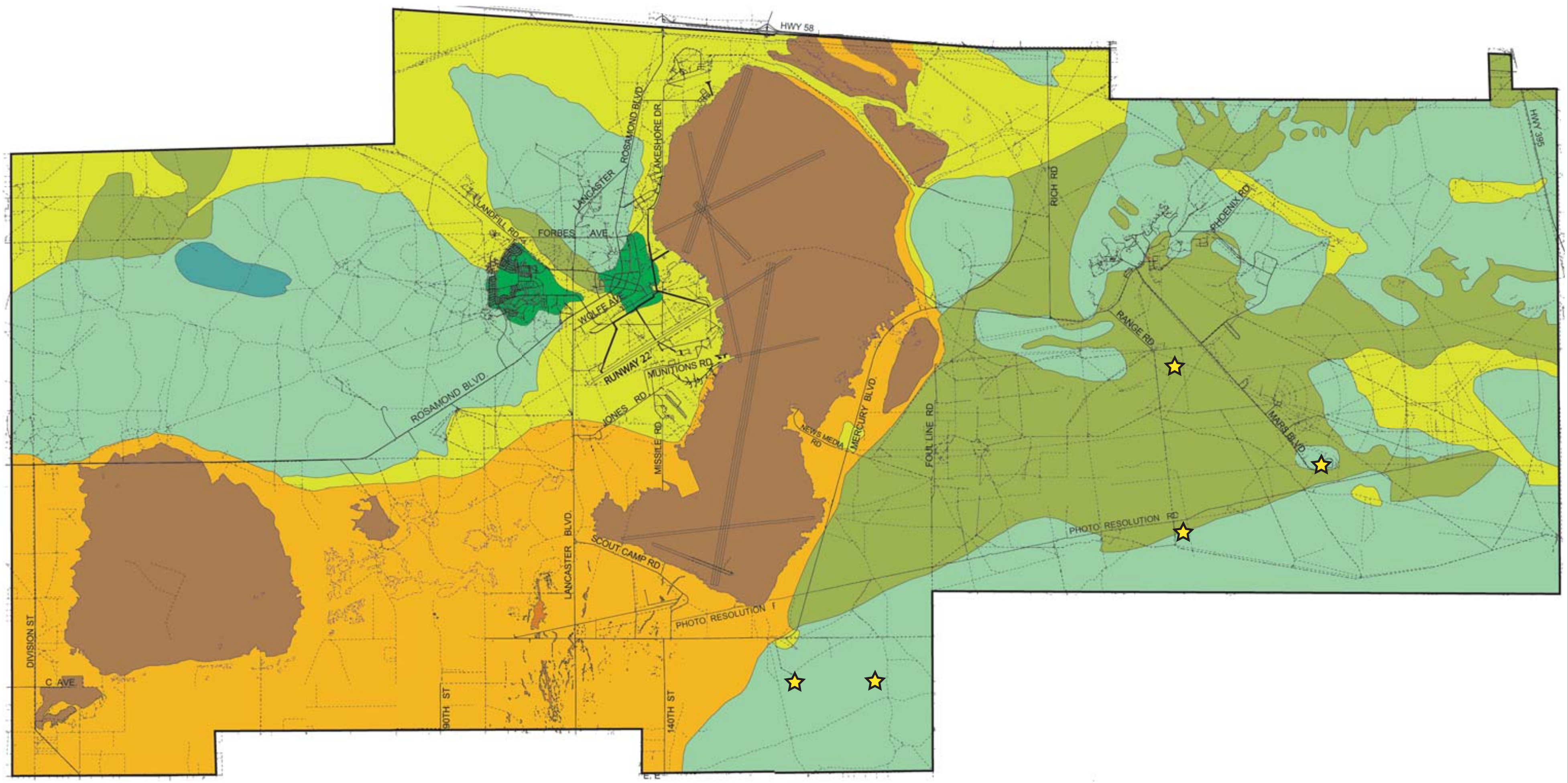
Plant Communities

The five major plant communities at Edwards AFB are creosote bush scrub, Joshua tree woodland, halophytic phase saltbrush scrub, xerophytic saltbrush scrub, and mesquite woodland (Figure 3-11). Four of the five plant communities occurring on Edwards AFB occur on the PIRA. Two of the proposed target sites that occur at Mt. Mesa area are in creosote bush scrub, two proposed target sites are in transition areas between creosote bush scrub and Joshua tree woodland, and one proposed target is in Joshua tree woodland. Three of the proposed target sites are located on alluvial fans, and two proposed target sites are located on rocky hillsides.

Creosote bush scrub is dominated by creosote bush (*Larrea divaricata*). At Edwards AFB, there are approximately 103,000 acres of creosote bush scrub, which comprises approximately 34 percent of the base area. Creosote bush scrub is distributed throughout the northwestern and eastern portions of the base and supports the highest plant diversity in the area (Edwards AFB 2002). Common species found in this community include winterfat (*Ceratoides lanata*), cheesebush (*Hymenoclea salsola*), and Nevada tea (*Ephedra nevadensis*).

Joshua tree woodland is dominated by Joshua trees (*Yucca brevifolia*) and is most prevalent east of Rogers Dry Lake, with small patches occurring in the northwest. At Edwards AFB, there are approximately 52,800 acres of Joshua tree woodland, which comprises approximately 17 percent of the area of the base. Common species found in this community include the native desert dandelion (*Malacothrix glabrata*), pincushion (*Chaenactis* sp.), and fiddleneck (*Amsinckia tesselata*).

Halophytic phase saltbrush scrub is dominated by four species of the genus *Atriplex*: spinescale (*A. spinifera*), shadescale (*A. confertifolia*), four-wing saltbush (*A. canescens*), and quailbush (*A. lentiformes*).



LEGEND

Unpaved Roads

Paved Roads

Taxiways

Base Boundary

HABITATS AND PLANT COMMUNITIES

- Xerophytic Saltbush Scrub
- Urban/Developed Areas
- Playa
- Mesquite Woodland
- Joshua Tree Woodland
- Halophytic Saltbush Scrub
- *Hymenoclea-Lycium* Scrub
- Creosote Bush Scrub

0 2 4 6

SCALE IN STATUTE MILES

LTAs (not to scale; locations are approximations)

EA FOR THE TESTING AND EVALUATION OF DIRECTED ENERGY SYSTEMS USING LASER TECHNOLOGY AT EDWARDS AFB

HABITATS AND PLANT COMMUNITIES AT EDWARDS AFB

TC#	DATE	DRAWN BY	FILENAME	FIGURE NO.
Q242-04	1/10/05	IGE	4592	3-11

At Edwards AFB, there are approximately 55,300 acres of halophytic phase saltbush scrub, which comprises approximately 18 percent of the area of the base. A common species found in this community is saltgrass (*Distichlis spicata*).

Arid phase saltbush scrub is dominated by allscale (*Atriplex polycarpa*). At Edwards AFB, there are approximately 45,300 acres of arid phase saltbush scrub, which comprises approximately 15 percent of the area of the base. Common species found in this community include burrobush (*Ambrosia dumosa*), goldenhead (*Acamptopappas sphaerocephalus*), and cheesebush (*Hymenoclea salsola*).

Lakebeds, claypans, and dunes occur from Piute Ponds in the southwestern corner of the base through Rosamond and Rogers Dry Lakes, to an area between the northeastern limits of Rogers Dry Lake and Rich Road. Smaller playas and claypans are found throughout the rest of the base.

Azonal Habitats

Azonal habitats are those natural and human-influenced plant and wildlife associations that are not restricted by elevation, but by other biotic and abiotic factors such as human disturbance or waste. Azonal habitats at Edwards AFB include

- Dry wash with mesquite woodlands;
- Dry wash without mesquite woodlands;
- Hymenoclea-Lycium scrub;
- Artificial aquatic habitats;
- Urban landscape;
- Rock outcrops and hillsides;
- Caves and mines;
- Dunes;
- Claypans;
- Alluvial fans;
- Alkali meadow; and
- Ditches and canals.

Sensitive Plant Species

Twelve sensitive plant species have been documented on Edwards AFB. Of these, seven occur on the PIRA or Desert Tortoise Management Area (Table 3-13).

Table 3-13

Sensitive Plant Species at Edwards AFB

Common Name	Scientific Name	CNPS	Habitat	Range
Desert cymopterus*	*Cymopterus deserticola*	1B	Any sandy substrate	W Mojave endemic
Barstow woolly sunflower*	*Eriophyllum mohavense*	1B	Clay pan edges	W Mojave endemic
Lancaster milkvetch	*Astragalus preussei laxiflorus*	1B	Halophytic saltbush	W Mojave/Nevada
Alkali mariposa lily*	*Calochortus striatus*	1B	Halophytic saltbush	Widespread at springs
Pygmy poppy*	*Canbya candida*	IB	Joshua Tree Woodland	Widespread
Twisselman poppy	*Eschscholtzia twisselmanii*	1B	Creosote Bush Scrub	El Paso Range-vicinity endemic
Mojave spineflower*	*Chorizanthe spinosa*	4	Saltbush scrub	W Mojave endemic
Yellow spiny cape*	*Gilmania luteola*	4	Halophytic saltbush	Widespread
Sage loeflingia*	*Loeflingia squarrosa artemisiarum*	4	Halophytic saltbush	Widespread
Crowned onion	*Muilla coronata*	4	Xerophytic saltbush	Widespread
Slender threadstem	*Nemacladus gracilis*	4	Sand dunes/fields	Widespread
Hoover's woolly star	*Eriastrum hooveri*	4	Sandy soils	Central Valley, scattered in desert

Note: * - Documented on the PIRA/Complex 1 Charlie (Edwards AFB Desert Tortoise Management Plan).
CNPS - California Native Plant Society Status
List 1B – Plants of very limited distribution; global populations potentially threatened
List 4 – Widespread and common - status does not warrant further consideration at this time

Desert cymopterus has a limited range within the West Mojave Desert, primarily between Rogers Lakebed and Superior Valley. Its habitat is limited to deep sandy soils. Most populations occur within the PIRA on Edwards AFB, with the largest populations south of Mars Boulevard. Adjacent populations to the proposed target sites are shown of Figure 3-11. Small scattered populations can be found in sandy areas throughout the PIRA. Although this species is a perennial, not all the plants come up each year. Populations increase in size in proportion to rainfall.

Accurate records of population boundaries can only be documented if rainfall is over 10 inches in a season. None of the sites will directly affect known desert cymopterus populations. Populations potentially impacted by this project would consist of scattered individuals and would not be significant. Approximately 75,000 plants have been documented by recent studies. Significant populations have been identified outside of Edwards AFB.

Barstow woolly sunflower is also a West Mojave Desert endemic species, occurring from Buckhorn Lake on Edwards AFB east to Coolgaardie Mesa. This small annual's habitat is limited to the edges of bare areas primarily in xerophytic phase saltbush scrub. Barstow woolly sunflower has been documented only in the northeastern portion of the PIRA. Known populations are not located near any proposed sites.

Alkali mariposa lily is a rare endemic of moist alkaline areas in the arid interior of southern California and southern Nevada. In California, populations are scattered in Kern, northeastern Los Angeles, and southern and central San Bernardino counties. Alkali mariposa lily grows in calcareous sandy soil in seasonally moist alkaline habitats such as alkali meadows, ephemeral washes, vernally moist depressions and at seeps within saltbush scrub at 300-4500 feet above MSL. These plants are not found in soils with surface salts, or wetter areas with permanent standing surface water. The bulb remains dormant and does not sprout in dry years. There were about 6,000 plants reported for Kern County from 1988-1992. Even though this species occurs on a large number of quads, most of the populations are small with the exception of the metapopulation extending from Lancaster to Edwards AFB. There are as many as 165,000 plants in 67 areas documented on Edwards AFB (Greene and Sanders n.d.). This species will not be impacted by proposed construction because this is a lowland species, and all the target sites are in upland habitat.

Pygmy poppy occurs in scattered, small populations in sandy soils throughout the western and northern Mojave Desert. Several scattered populations occur north of Mars Boulevard on the PIRA. Other known locations on Base occur near Buckhorn Lakebed. No documented populations occur near the proposed sites.

Mohave spineflower was delisted from List 1B because it was found to be more common within its limited range after surveys for this species were conducted in the 1990s. In addition, spineflower does well in disturbed soils. Spineflower habitat is limited to saltbush scrub. The proposed sites are not located in this plant community.

Yellow spiny cape and sage loeflingia occur in sandy soils on flats in halophytic phase saltbush scrub. Yellow spiny cape prefers salt encrusted dune swale habitat, and sage loeflingia prefers loose sand. Such habitat occurs on the western edge of the Mt. Mesa Desert Tortoise Management Area along with the alkali mariposa lily. No sites are proposed in this habitat.

3.9.1.2 Wildlife

Five eubranchiopod shrimp species have been identified in Rogers Dry Lake: clam shrimp (*Eocyzicus digueti*), tadpole shrimp (*Lepidurus lemmoni*), and three species of fairy shrimp (*Branchinecta mackini*, *B. gigas*, and *B. lindahli*) (AFFTC 1992). Eubranchiopods lie dormant in the soil of dry lakebeds until flooding creates the aquatic habitat necessary to complete their life cycles. These shrimp are a food source for a variety of migratory waterfowl and wading birds that congregate at Rogers Dry Lake when water is present.

To date, the only amphibians identified on Edwards AFB include the western toad (*Bufo boreas*), Pacific tree frog (*Hyla regilla*), red-spotted toad (*Bufo punctatus*), and African clawed frog (*Xenopus laevis*). These were identified at Piute Ponds by USGS biologists during a survey in 1997. The African clawed frog is a problematic introduced species that feeds on native wildlife, including other amphibians, small reptiles, and fish (AFFTC 1997c). Common reptiles include the desert spiny lizard (*Sceloporus magister*), side-blotched lizard (*Uta stansburiana*), western whiptail *(Cnemidophorus tigris)*, zebra-tailed lizard (*Callisaurus draconoides)*, glossy snake (*Arizona elegans*), coachwhip (*Masticophis flagellum*), gopher snake (*Pituophis melanoleucus*), and the Mojave green rattlesnake (*Crotalus scutulatus*).

Common birds include the turkey vulture (*Cathartes aura*), common raven (*Corvus corax*), sage sparrow (*Amphispiza belli*), barn owl (*Tyto alba*), house finch (*Carpodacus mexicanus*), and western meadowlark (*Sturnella neglecta*). Joshua tree woodlands support cactus wren (*Campylorhynchus brunneicapillus*) and ladder-backed woodpecker (*Picoides scalaris*). Common bird species found in creosote scrub include the horned lark (*Eremophila alpestris*), black-throated sparrow (*Amphispiza bilineata*), and sage sparrow. The seasonal inundation of lakebeds and claypans attracts wading bird species, including the black necked stilt (*Himantopus mexicanus*), American avocet (*Recurvirostra americana*), and greater yellowlegs (*Tringa melanoleuca*). Birds associated with ponds include the yellow-headed blackbird (*Xanthocephalus xanthocephalus*), black-crowned night heron (*Nycticorax nycitorax*), and green heron (*Butorides striatus*).

Horned larks are commonly found in open habitat with sparse vegetation or areas of low shrubs (i.e., open field, agricultural areas, desert habitat, prairies, and grassland communities). The main runways on Edwards AFB are surrounded by arid phase saltbush scrub. Combined with open areas along the flightline, this habitat is suitable for horned larks. The vegetation adjacent to the runways is periodically graded, creating a buffer area devoid of vegetation, which also provides additional foraging habitat for horned larks. Methods that have been used at Edwards AFB to control the bird airstrike problem with horned larks include revegetation with native plants and use of a falconer.

The storm water retention pond along the flightline attracts other types of birds (e.g., waterfowl, shorebirds) and possibly bats associated with aquatic habitats. Barn owls (*Tyto alba*) are known to inhabit buildings on the flightline. During the evening, owls feed on small rodents adjacent to the runways and in other areas nearby.

Common mammals on Edwards EFB include the black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus audobonii*), and coyote (*Canis latrans*). Common rodents include the deer mouse (*Peromyscus maniculatus*), grasshopper mouse (*Onychomys torridus*), little pocket mouse (*Perognathus longimembris*), Merriam's kangaroo rat (*Dipodymus merriami*), and desert woodrat (*Neotoma lepida*). Common bats include the western pipistrelle (*Pipistrellus hesperus)*, and little brown bat (*Myotis lucifugus*).

Sensitive Wildlife Species

A more detailed listing of sensitive wildlife species can be found in the Edwards AFB INRMP (Edwards AFB 2004). Of particular interest for this project are the desert tortoise and the Mohave ground squirrel. The desert tortoise is listed as threatened by the federal government and by the State of California. It can occur throughout the Colorado and Mojave deserts in elevations up to 4,100 feet, although ideal habitat typically occurs between 1,000 and 3,000 feet (Edwards AFB 2002). The desert tortoise can occur in almost every desert habitat, but is most common in desert washes, desert scrub, creosote bush, and Joshua tree habitats. This species finds cover in burrows that are usually under bushes and requires loose, dry, sandy soil for nest building. They are more active during the spring and summer months. The desert tortoise is a herbivorous reptile whose native range includes the Sonoran and Mojave deserts of southern California, southern Nevada, Arizona, extreme southwestern Utah, and Sonora and northern Sinaloa, Mexico.

The Mohave ground squirrel listed by the state of California as threatened; it is found in the Mojave Desert in San Bernardino, Los Angeles, Kern, and Inyo Counties including Edwards AFB in Region 1. Populations are known to occur north and south of Rogers Dry Lake and the PIRA. This species is rare throughout its range. Populations in southwestern San Bernardino County appear to be extirpated. Optimal habitats are open desert scrub, alkali desert scrub, and Joshua tree and they also feed in annual grasslands. Mohave ground squirrels live in underground burrows, frequently among the roots of the creosote bush and have been found at elevations between 1,800 and 5,000 feet above MSL. They spend more time above ground in March through May.

Migratory Birds

Seasonal migratory birds use both permanent and temporary bodies of water for foraging on shrimp and other food items on Edwards AFB. These birds include ducks and geese such as the ruddy duck (*Oxyura jamaicensis*), northern mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), Canada goose (*Branta canadensis*), and snow goose (*Chen caerulescens*). Ducks and geese are hunted in designated areas on Edwards AFB.

3.9.1.3 Sensitive Habitats

Sensitive habitats in Edwards AFB include, but are not limited to, designated critical habitat for the desert tortoise, sensitive plant populations (refer to Section 3.9.1.1, Sensitive Plant Species), and SEAs as defined by the County of Los Angeles. The sensitive habitats discussed below are ones most relevant to the Proposed Action and Alternatives.

Designated Critical Habitat

Critical habitat on the PIRA generally consists of bedrock with a layer of blown sand. This portion of the PIRA primarily consists of a west-facing slope with a rise between Leuhman Ridge and Haystack Butte. Critical habitat is located on the southern border of Edwards AFB. In the west, the level portions of the land surface contain saltbush scrub on pan and dune habitat. East of the slope as elevations increase, soils become deeper and very sandy. The slopes contain creosote bush scrub vegetation with varying densities of Joshua trees. The Joshua trees average between small and moderate in size. In general, the health of the Joshua trees is not good. Sandy soils generally contain a relatively large diversity of shrubs and annuals, but the PIRA is an exception. Many areas of the PIRA are dominated by fiddleneck, but the timing of the rainfall and quantity of rain can result in spectacular wildflower displays.

In 1994, impacts to critical habitat were assessed in a Biological Opinion (USFWS 1994a). Determination of critical habitat area for the Mojave population of the desert tortoise was established by the Final Rule; *Federal Register*, 50 CFR Part 17, 59 FR 5820, February 8, 1994. Approximately 65,000 acres of the Base fall within the critical habitat of the Fremont-Kramer Desert Tortoise Critical Habitat Unit, which includes portions of the PIRA and Mt. Mesa (Management Area B) and the AFRL (located in Management Area G).

Desert Tortoise Management Zones

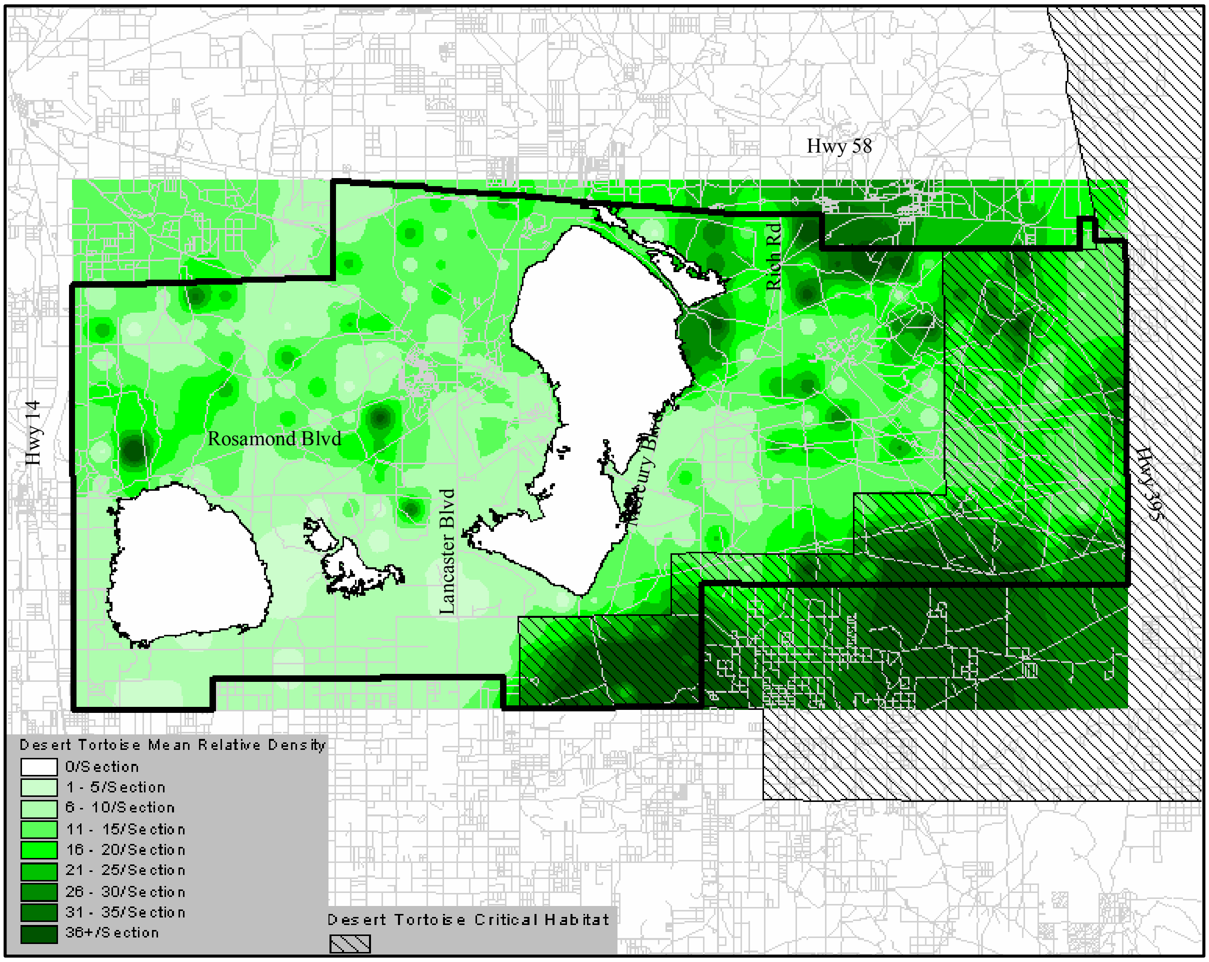
Desert tortoise management zones were determined by their relationship to critical habitat designation, prior historical military use of the PIRA, topography, and past desert tortoise density data. These areas are managed in conjunction with the West Mojave Plan's Fremont-Kramer Desert Wildlife Management Area (DWMA).

The western portion of the Edwards AFB Desert Tortoise Management Area (Mt. Mesa) is also located within the eastern portion of the Edwards SEA. This is the outflow of the Little Rock Creek drainage from the Transverse Range into Rogers Lakebed. This drainage is also identified as important habitat by the Nature Conservancy Ecosystem Management Plan. The relative density of desert tortoise populations at Edwards AFB is shown in Figure 3-12.

Significant Ecological Areas

The County of Los Angeles General Plan establishes 61 SEAs, which represent a wide variety of biological communities within the county. The SEAs function to preserve this variety to provide a level of protection to the resources within them. The SEAs are intended to be preserved in an ecologically viable condition for the purposes of education, research, and other non-disruptive outdoor users, but are not intended to preclude limited compatible development.

Los Angeles County has identified two SEAs on Region 1: Edwards AFB (SEA #47) and Rosamond Lake (SEA #50). The locations of these SEAs are shown on Figure 3-13. SEA #47 contains botanical features that are unique and limited in distribution in Los Angeles County. They include the only good stands of mesquite (*Prosopis glandulosa*) in Los Angeles County. The area contains fine examples of



Source: Edwards AFB Comprehensive Range Plan 2004

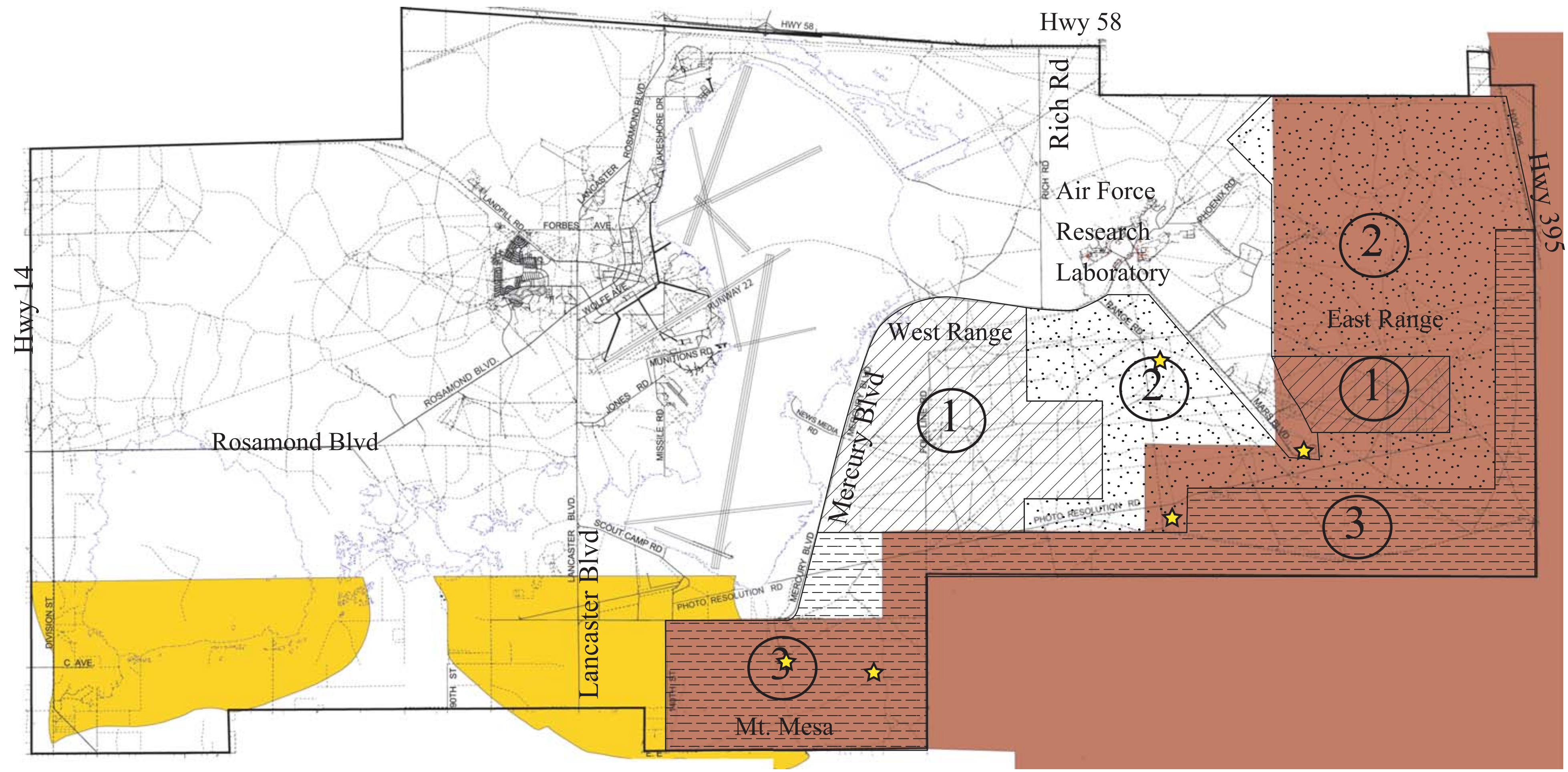
Figure 3-12

Desert Tortoise Relative Density Estimates on Edwards AFB

creosote bush scrub, alkali sink, and the transition vegetation between the two. Mesquite woodlands provide habitat for a variety of mammals, birds, and reptiles. The best example of shadscale scrub and alkali sink biotic communities in Los Angeles County are in SEA #50. It also contains Piute Ponds, which are located in the southwestern corner of the base. Piute Ponds support a variety of wildlife, especially birds. An important aspect of these ponds is that they provide a stopover area for migratory birds.

3.9.2 Natural Resources—Region 2

Region 2 includes the highest (Mount Whitney) and lowest (Death Valley) terrestrial elevations in the continental United States. These physical conditions have resulted in extremely diverse plant habitats in the R-2508 Complex. The plants and animals present within the R-2508 Complex are described briefly here and in detail in the *R-2508 Complex Environmental Baseline Survey* (95 ABW and AFFTC 2005).



LEGEND

Unpaved Roads

Paved Roads

Taxiways

Base Boundary

SENSITIVE WILDLIFE HABITAT

Los Angeles County Significant Ecological Area (SEA)

Desert Tortoise Critical Habitat

Desert Tortoise Management Zone 1

Desert Tortoise Management Zone 2

Desert Tortoise Management Zone 3

N

0 2 4 6

SCALE IN STATUTE MILES

LTAs (not to scale; locations are approximations)

EA FOR THE TESTING AND EVALUATION OF DIRECTED ENERGY SYSTEMS USING LASER TECHNOLOGY AT EDWARDS AFB

TWO SENSITIVE WILDLIFE HABITATS AT EDWARDS AFB

TC#	DATE	DRAWN BY	FILENAME	FIGURE NO.
Q242-04	1/10/05	IGE	4592	3-13

3.9.2.1 Plants

Hickman (1993) has divided California's biological resources into provinces, the following three of which are included in the R-2508 Complex: (1) the Desert Province of southeastern California, (2) the California Floristic Province, and (3) the Great Basin Province Area. The province, location by county and state, and area in the R-2508 Complex where plants can be found are presented in Table 3-14.

Table 3-14

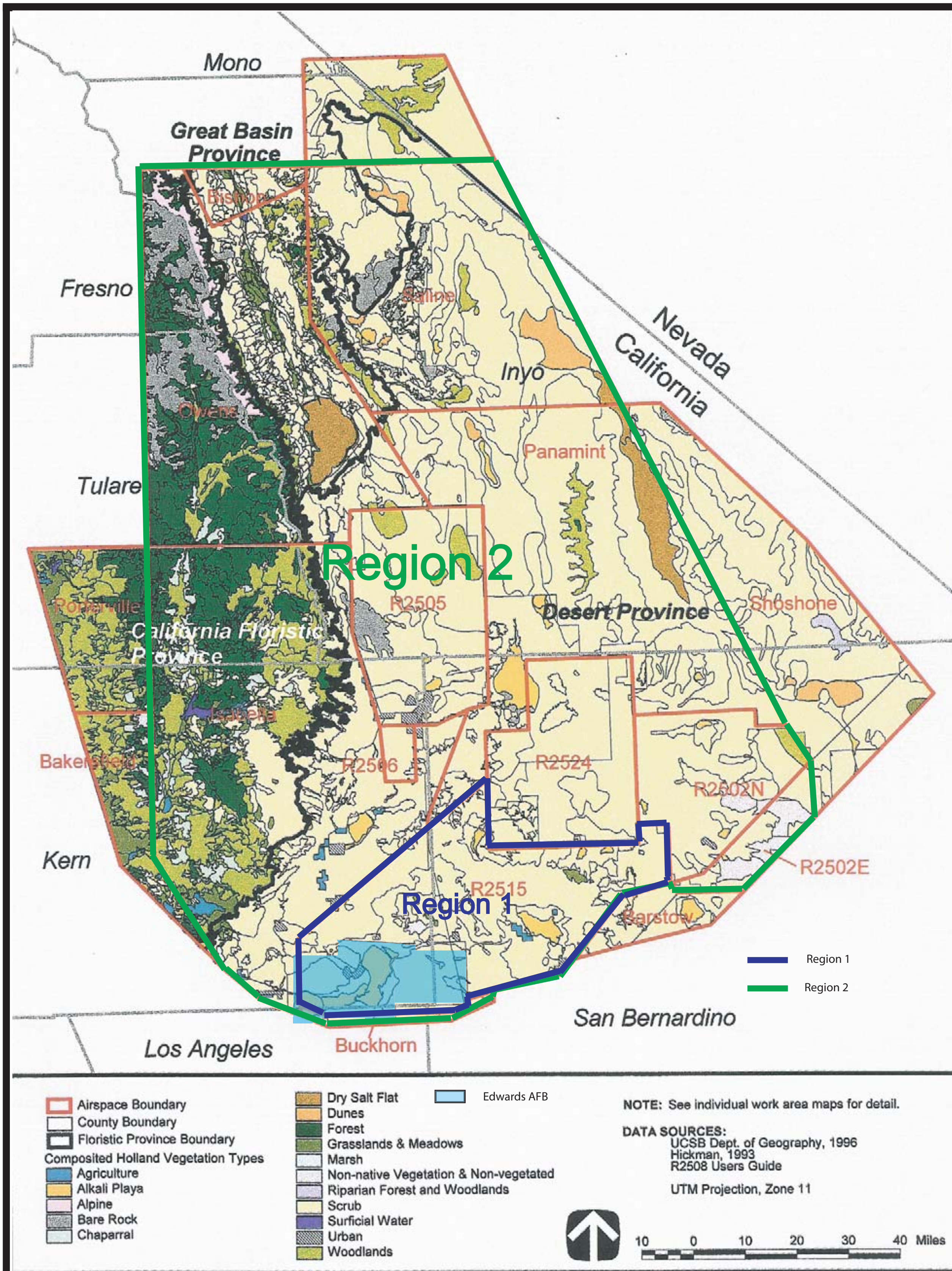
Floristic Provinces Underlying the R-2508 Complex

Floristic Province	County and State	Areas of the R-2508 Complex
Desert	San Bernardino, Kern, Inyo, CA; Esmeralda, NV	R-2515, R-2524, R2502, R-2506, R-2505, Panamint, and portions of the Saline, Owens, and Isabella Areas
California Floristic	Kern, Tulare, Fresno, and Inyo, CA	Portions of Owens and Isabella Areas
Great Basin	Fresno, CA	All of Bishop and portions of the Owens, Saline, and Panamint Areas

The composited vegetation types and boundaries are included in Figure 3-14. The boundaries are not absolute, and many vegetation types can be found in all three provinces. The majority of the Complex (approximately 70 percent) is dominated by scrub communities. Woodlands and forests, the majority of which are associated with the foothills and mountains of the Sierra Nevada in the California Floristic Province, account for just under 20 percent of the vegetation in the R-2508 Complex. Urban areas, agricultural areas, barren areas, and non-native vegetation communities together account for less than 2 percent of the land area in the R-2508 Complex. Although large perennial and ephemeral water bodies (Section 3.14, Water Resources) are uncommon in the R-2508 Complex, they support many of the sensitive species in the Complex and are important as stopover areas for migratory birds. Alkali playas, dry salt flats, marshes, surficial water bodies, and riparian vegetation together comprise only 3 percent of the area.

3.9.2.2 Wildlife

A detailed description of the wildlife living in the R-2508 Complex can be found in the *R-2508 Complex Environmental Baseline Survey* (95 ABW and AFFTC 2005). The Desert Province supports a diverse invertebrate assemblage represented by characteristic species. A large number of the species occur within the ephemeral playas and claypans. Fishery resources in the desert province are mainly limited to habitats associated with the Amargosa and Mojave River drainages and gamefish-stocked recreational ponds and lakes. All of the native fish species remaining in the drainages are considered sensitive. Amphibians are



Provinces and Vegetation in Regions 1 and 2	Figure 3-14	Q242-04	01/06/05

relatively uncommon in the desert and are generally only found in very close association with water. The desert province supports a large number of mammals including rodents, rabbits, squirrels, bats, and carnivores such as coyotes, foxes, mountain lions, and badgers. The diverse avifuana includes many resident, migratory, wintering, and transient species. The R-2508 Complex is within the Pacific Flyway, the major north-south corridor for migratory birds.

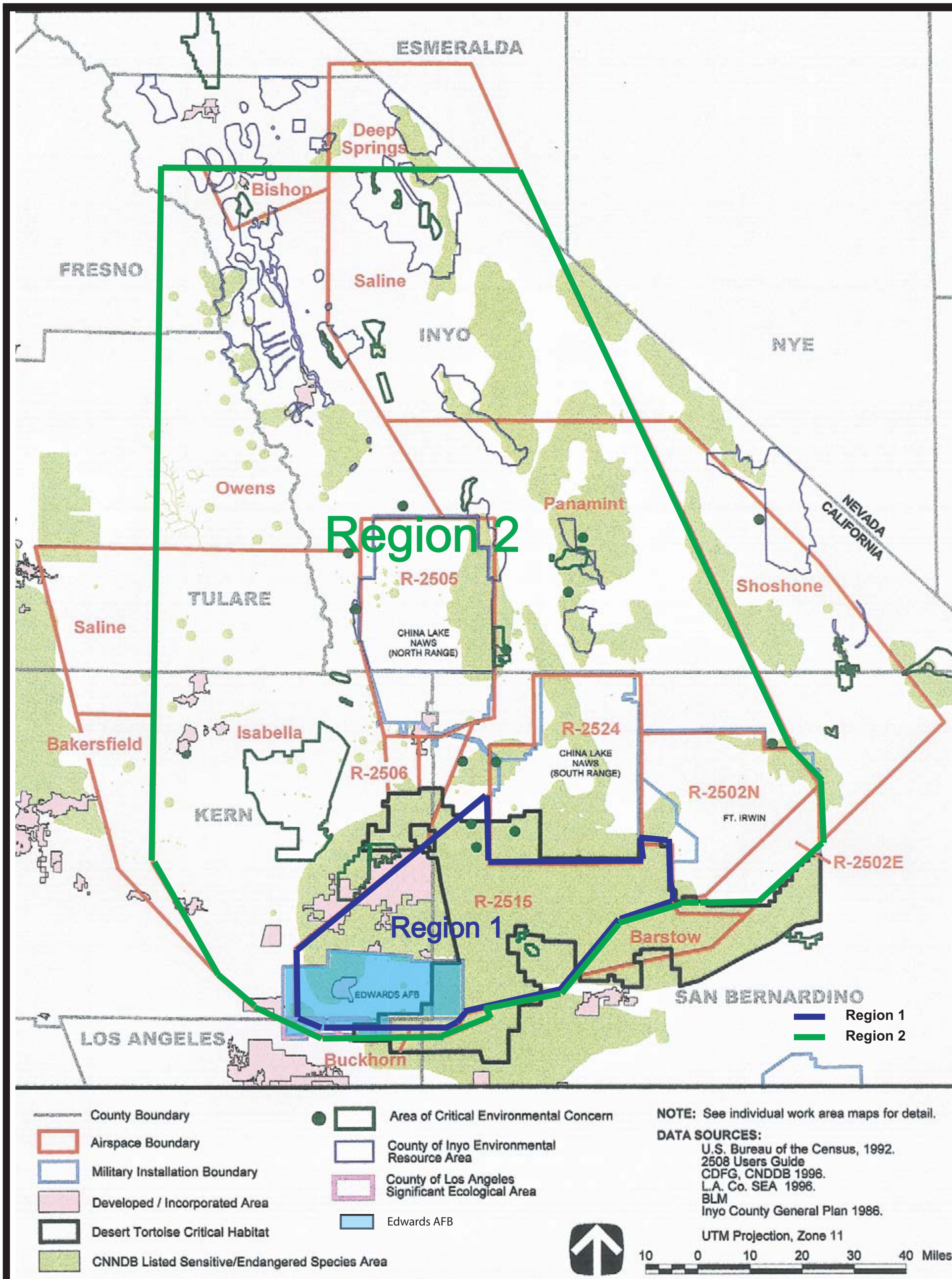
Many of the wildlife species described for the Desert Province are also common in the Great Basin Province including carnivores, raptors, bats, and many of the scrub-associated avian species. There is a greater representation of amphibian and reptile species in the province than in the Desert Province. The Owens River is the major drainage, and native fish species are uncommon. Ungulates include deer, pronghorns, elk, and bighorn sheep. Carnivores also include skunks, raccoons, gray foxes, and black bears.

The Kern River system is the major drainage of the portion of the R-2508 Complex within the California Floristic Province. Native fishes include several species of trout and mosquitofish (the most common introduced species in the drainage). The Sierra Nevada and Great Valley support a wide variety of reptile and amphibian species such as salamanders, toads, frogs, lizards, snakes, and turtles. Avian species include raptors, several species of sparrows, and a number of others that are characteristic of the region. Mammals include those described for the Desert Province and Great Basin Province as well as marten, weasel, skunk, porcupine, squirrel, and beaver.

3.9.2.3 Sensitive Species and Habitats

Twenty-six federally listed or proposed species are known to occur in the R-2508 Complex. These include nine plants, two invertebrates, four fishes, one reptile, eight birds, and two mammals. Numerous state-listed species, federal and state species of concern, and other sensitive species are known to occur in the R-2508 Complex. Figure 3-15 shows reported or known occurrences and habitat for selected sensitive wildlife species throughout the Complex as designated by the California Department of Fish and Game and California Natural Diversity Database.

The BLM has designated 39 areas of critical concern (AECs) for various biological resources within the R-2508 Complex. In addition, two counties within the R-2508 Complex have special designations for important environmental resource regions. The County of Los Angeles has designated two SEAs that are located in restricted area R-2515 and Buckhorn MOA (see Figure 3-13). Inyo County has designated 30 Environmental Resource Areas for biological resources that are located through the northeastern part of



Sensitive and Endangered Species in Regions 1 and 2	Figure 3-15	Q242-04	01/06/05

the R-2508 Complex. Many of these areas are associated with bighorn sheep, deer, and elk habitat in the Owens, Panamint, Bishop, and Deep Springs MOAs.

3.10 NOISE

3.10.1 Noise Characteristics

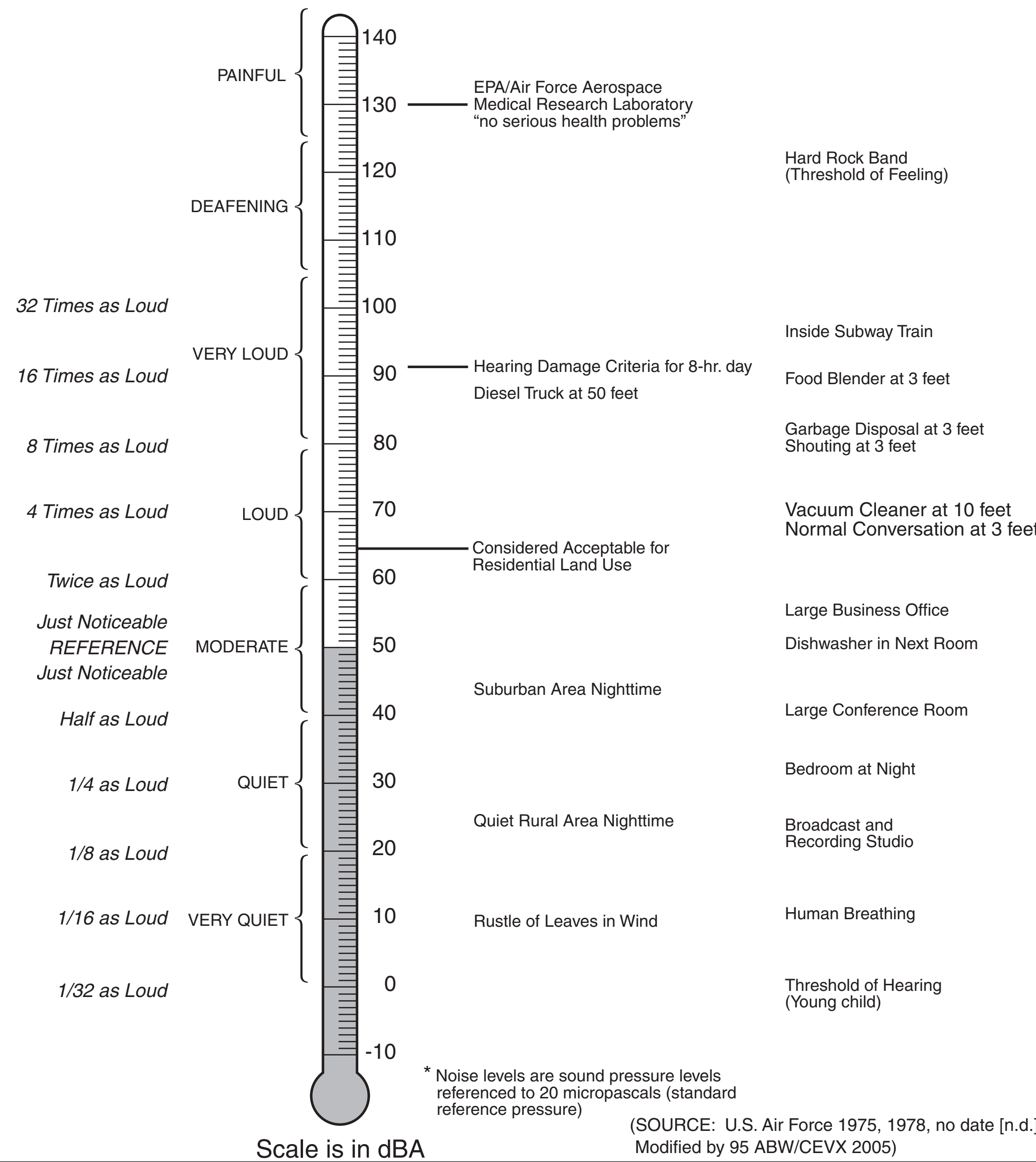
In 1972, Congress enacted the Noise Control Act, P.L. 92-574. Among the requirements under the NCA was a directive to the U.S. EPA to "…publish information on the levels of environmental noise, the attainment and maintenance of which in defined areas under various conditions as requisite to protect the public health and welfare with an adequate margin of safety." The U.S. EPA published EPA-550/9-47-004, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, in 1974 (Levels Document; U.S. EPA 1974).

The characteristics of sound include parameters such as amplitude, frequency, and duration. The decibel (dB), a logarithmic unit that accounts for the large variations in amplitude, is the accepted standard unit measurement of sound. Different sounds may have different frequency content. When measuring sound to determine its effects of the human population, A-weighted sound levels (dBA) represent adjusted sound levels. The adjustments, created by the ANSI in 1983, are established according to the frequency content of the sound. Examples of typical A-weighted sound levels are shown in Figure 3-16.

Noise is usually defined as sound that is undesirable because it interferes with communication and hearing, is intense enough to damage hearing ability, or is otherwise annoying. Noise levels often change with time. Therefore, to compare levels over different time periods, several descriptors were developed to account for the time variances.

These descriptors are used to assess and correlate the various effects of noise on humans, including land use compatibility, sleep and speech interference, annoyance, hearing loss, and startle effects.

- A-weighted decibel scale (dBA). This scale simulates the range of sound that is audible by the human ear. The A-weighted scale significantly reduces the measured pressure level for low frequency sounds while slightly increasing the measured pressure levels for middle frequency sounds. A-weighted sound levels represent adjusted sound levels that are typically measured between 1,000 and 4,000 hertz (Hz).



(SOURCE: U.S. Air Force 1975, 1978, no date [n.d.] Modified by 95 ABW/CEVX 2005)

Examples of Typical A-Weighted Sound Levels	Figure 3-16	Q242-04	01/06/05

- The long-term equivalent A-weighted sound level (Leq). This describes time-varying noise energy as a steady noise level.

- Day-night average noise level (DNL). The DNL, often referred to as L_{dn}, has been adopted by federal agencies as the standard for measuring noise. The DNL is an A-weighted, 24-hour average of hourly averages. Each hourly average represents the sound energy of all the disparate sounds that occurred during that hour. The hourly average would be a continuous, uniform sound whose total sound energy would be equal to the sum of the individual sound energies of all the real sounds occurring during that hour. Typically, different hours of the day would have different hourly averages. For this reason, and for standardization, the DNL is defined as the average of the 24 hourly averages of the day.

- C-weighted sound level. C-weighting measures sound levels in dB, with no adjustment to the noise level over most of the audible frequency range except for a slight de-emphasis of the signal below 100 Hz and above 3,000 Hz. C-weighting is used as a descriptor of low-frequency noise sources, such as blast noise, explosive detonations, and sonic booms.

- C-weighted day-night level (CDNL) is the C-weighted sound level averaged over a 24-hour period, with a 10-dB penalty added for noise occurring between 10:00 p.m. and 7:00 a.m. CDNL is similar to DNL, except that C-weighting is used rather than A-weighting. CDNL is used to evaluate human response or annoyance to noise sources, such as blast noise and sonic booms.

- Sound exposure level (SEL) considers both the A-weighted sound level and duration of noise. SEL converts the total A-weighted sound energy in a given noise event with a given duration into a 1-second equivalent and, therefore, allows direct comparison between sounds with varying intensities and durations.

- C-weighted sound exposure level (CSEL) is an SEL measurement based on the C-weighted level rather than the A-weighted level.

- Sound pressure level is a logarithmic scale, using dB as units, and a reference pressure that corresponds approximately to the minimum audible sound pressure.

- Community noise equivalent level (CNEL) has been adopted by the State of California as the descriptor for measuring noise levels. The CNEL is similar to the DNL, except that it includes a 5 dB penalty for evening noise (7:00 p.m. to 10:00 p.m.) in addition to the 10 dB "penalty" for nighttime noise.

In the Levels Document, the U.S. EPA reported that the best metrics to describe the effects of environmental noise in a simple, uniform, and appropriate way were:

- The L_{eq}; and
- The DNL or L_{dn} (a variant of L_{eq} that incorporates a 10-dB "penalty" for nighttime noise).

Another factor that describes how noise is characterized and analyzed is whether the noise source is continuous or impulsive. Continuous noise sources are from highways, construction sites, and cities with heavy traffic and large airports. Impulsive noise generated from munition and ordnance explosions resulting from being targeted by a laser beam would be fundamentally different from the continuous noise. For example, permanent damage to unprotected ears due to continuous noise occurs at approximately 85 dB based on an 8-hour-per-day exposure, while the threshold for permanent damage to unprotected ears due to impulsive noise is approximately 140 dB peak noise based on 100 exposures per day (Pater 1976).

Thus given the continuous noise versus impulsive type of noise, the variations in frequency and period of noise exposure, and the fact that the human ear cannot perceive all pitches and frequencies equally well, a number of different measures of noise levels are used in this assessment: the peak sound level, the SEL, and the DNL.

3.10.2 Measurements of Aircraft Noise Impact on Human Annoyance

In 1977, at the request of the U.S. EPA, the National Academy of Science's Committee on Hearing, Bioacoustics and Biomechanics (CHABA) proposed guidelines for the uniform description and assessment of the various noise environments associated with various projects. In 1982, the U.S. EPA published *Guidelines for Noise Impact Analysis*, based on the CHABA Guidelines. According to CHABA Guidelines, the L_{eq} and DNL were selected as the appropriate descriptors for noise because they reliably correlate with health and welfare effects. From data on community social surveys, DNL has been found to correlate with community annoyance, as measured in terms of percentage of exposed persons who are "highly annoyed" (Table 3-14). Correlation between DNL and CDNL has been established based on community reaction to impulsive sounds (CHABA 1981). The DoD has followed the recommendations of CHABA in describing high-intensity impulsive sounds, such as explosions, in terms of C-weighted sound exposure level. Table 3-15 shows the relationship between the percent of the population highly annoyed by sound levels expressed as DNL and CDNL.

Table 3-15

Relationship Between C-Weighted and A-Weighted Sound Levels and Percent of the Population Annoyed

CDNL (C-weighted)	% Highly Annoyed	DNL (A-weighted)
48	2	50
52	4	55
57	8	60
61	14	65
65	23	70
69	35	75

Note: CDNL can be interpreted in terms of "equivalent annoyance" DNL.

Source: Committee on Hearing, Bioacoustics and Biomechanics 1981.

A DNL of 65 dBA or lower is considered to be acceptable (Table 3-15); a DNL above 65 dBA but not exceeding 75 dBA is normally unacceptable unless some form of noise attenuation is provided; a DNL higher than 75 dBA is unacceptable. Daily exposure to impulsive noise of CDNL of 61 dBC or less is comparable to the DNL 65 dBA significance level for non-impulsive noise and is normally considered compatible with most land uses.

3.10.3 Measurements of Noise Impact on Land Use Compatibility

In 1980, the Federal Interagency Committee on Urban Noise (FICUN) published guidelines for considering noise in land use planning (FICUN 1980). Federal agencies have adopted these guidelines as the standard when making recommendations to local communities on land use compatibility issues. Table 3-16 shows the types of land uses that would be appropriate based on a range of DNL values.

3.10.4 Existing Noise Setting

3.10.4.1 Noise—Region 1

Major noise sources at Edwards AFB and Region 1 are aircraft operations that include rotary wing air traffic, engine testing, sonic booms, and vehicle traffic on streets. The major sources of motor vehicle-

Table 3-16

Land Use Compatibility

Land Use	Yearly Day-Night Average Sound Level (DNL) in Decibels					
	Below 65	**65–70**	**70–75**	**75–80**	**80–85**	**Over 85**
Residential						
Residential, other than mobile homes and transient lodgings	Y	N[1]	N[1]	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N[1]	N[1]	N[1]	N	N
Public Use						
Schools	Y	N[1]	N[1]	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoria, and concert halls	Y	25	30	N	N	N
Government services	Y	Y	25	30	N	N
Transportation	Y	Y	Y[2]	Y[3]	Y[4]	Y[4]
Parking	Y	Y	Y[2]	Y[3]	Y[4]	N
Commercial Use						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail—building materials, hardware, and farm equipment	Y	Y	Y[2]	Y[3]	Y[4]	N
Retail trade—general	Y	Y	25	30	N	N
Utilities	Y	Y	Y[2]	Y[3]	Y[4]	N
Communication	Y	Y	25	30	N	N

Table 3-16, Page 1 of 3

Table 3-16

Land Use Compatibility (Continued)

Land Use	Yearly Day-Night Average Sound Level (DNL) in Decibels					
	Below 65	65–70	70–75	75–80	80–85	Over 85
Manufacturing and Production						
Manufacturing, general	Y	Y	Y[2]	Y[3]	Y[4]	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y[6]	Y[7]	Y[8]	Y[8]	Y[8]
Livestock farming and breeding	Y	Y[6]	Y[7]	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas and spectator sports	Y	Y[5]	Y[5]	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts, and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N

Table 3-16, Page 2 of 3

Notes: Numbers refer to notes.

* - The designations contained in this table do not constitute a federal determination that any use of land covered by the program is acceptable or unacceptable under federal, state, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise-compatible land uses.

Y (Yes) - Land Use and related structures compatible without restrictions.

N (No) - Land Use and related structures are not compatible and should be prohibited.

Table 3-16

Land Use Compatibility (Continued)

Table 3-16, Page 3 of 3

Notes: (Continued)

NLR - Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.

25, 30, or 35 - Land Use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structures.

1 - Where the community determines that residential or school uses must be allowed, measures to achieve outdoor-to-indoor Noise Level Reduction (NLR) of at least 25 dB to 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide an NLR of 20 dB; thus the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year-round. However, the use of NLR criteria will not eliminate outdoor noise problems.

2 - Measures to achieve NLR 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

3 - Measures to achieve NLR 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.

4 - Measures to achieve NLR 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.

5 - Land-use compatible provided special sound reinforcement systems are installed.

6 - Residential buildings require an NLR of 25.

7 - Residential buildings require an NLR of 30.

8 - Residential buildings not permitted.

Source: 14 CFR Part 150

related noise at Edwards AFB are Lancaster Boulevard, Rosamond Boulevard, and primary and secondary streets on the base.

Noise estimates are usually presented as noise contours. Noise contours are lines on a map of an airfield and its vicinity where the same noise level is predicted to occur. The 5-dB interval chosen to represent noise contours reflects the U.S. Department of Housing and Urban Development (HUD) noise criteria commonly used for airfield noise (HUD 1978). Figure 3-17 presents CNEL noise contours at Edwards AFB.

As shown in Figure 3-17, Runway 04/22 noise contours for a CNEL of 65 dB and above lie completely within the boundary of Edwards AFB. Parts of the Region 1 recreation areas lie between the 65- and 70-dB contours. These areas include the Edwards AFB Rod and Gun Club (Combat Arms Range), base golf course, off-highway vehicle area number 1, and some of the picnic areas and athletic fields. The Main Base residential area is outside the 65-dB contour. The Main Base has a range of exposure from 65 to 85 dB; the South Base 70 to 85 dB. Region 1 land under the 80-dB noise contours is primarily open space and test program support area. The South Base and a portion of the Main Base are currently within the 80-dB noise level; therefore, small areas of administrative, commercial, and industrial land are subject to these noise levels.

The area around AFRL is subject to very high levels of noise during rocket engine tests. Test firings occur during daytime hours for 1 to 3 minutes on an infrequent basis. Personnel at the test site remain in buildings designed to protect them from high noise levels. Smaller engines are also tested at this location, and noise levels are less than half those produced by the large Titan engines. Approximately 1,750 people reside within the 80-dB contours of Titan test firings. The BFTF is one of the designated control areas for laser test and evaluation. The noise levels at the BFTF, located on the southeast side of the main runway and approximately 1.5 nautical miles from the Main Base is between the 65- and 75-dB noise contours (U.S. Air Force 1997).

3.10.4.2 Noise—Region 2

The land under the R-2508 Complex consists primarily of open space, but includes industrial, residential, commercial, and public/recreation centers as well. The MOA Range NOISEMAP (MR_NMAP) noise model was used to develop the ambient noise contours for restricted area R-2515. The models in MR_NMAP together are representative of the way aircraft fly in military airspace. There are three general representations: broadly distributed operations that generally occur in MOAs and ranges, distributed parallel tracks that occur along military training routes, and specific tracks that occur in target

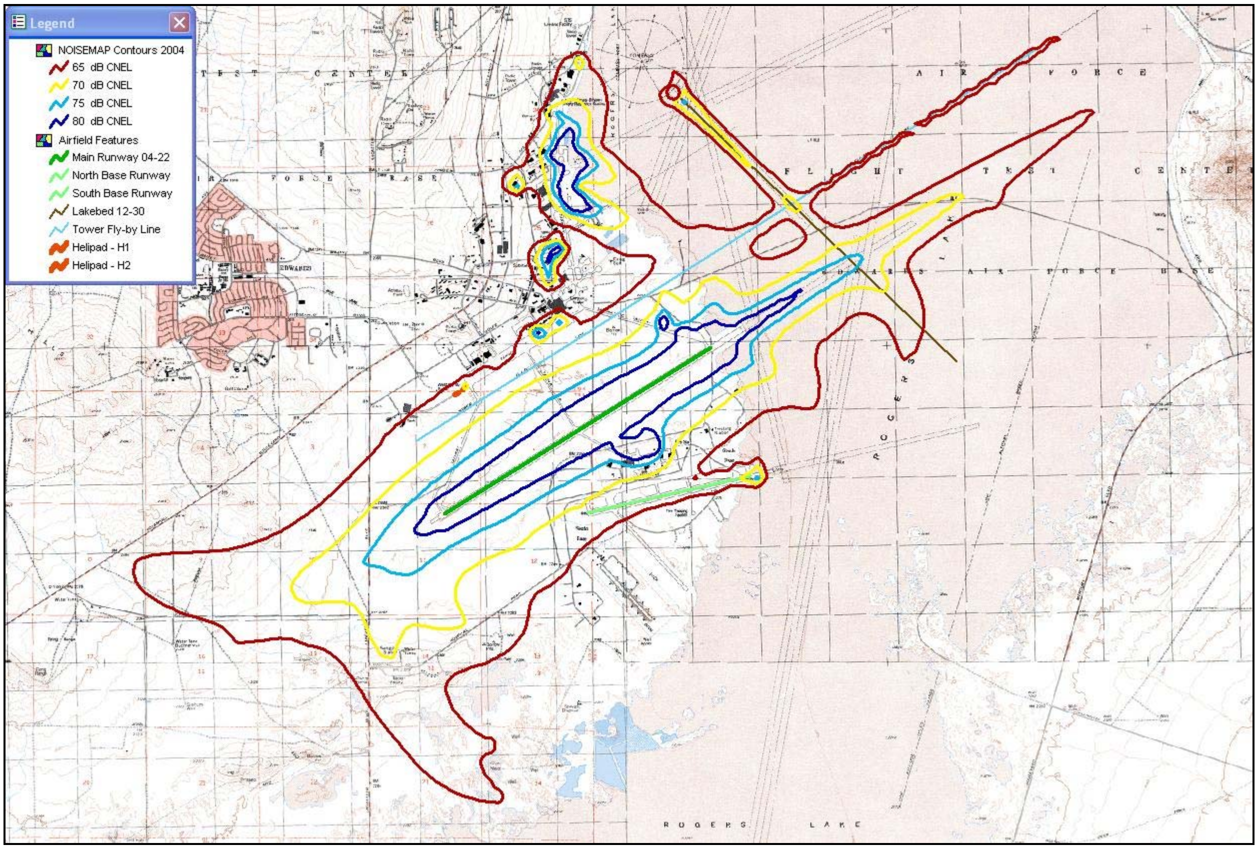
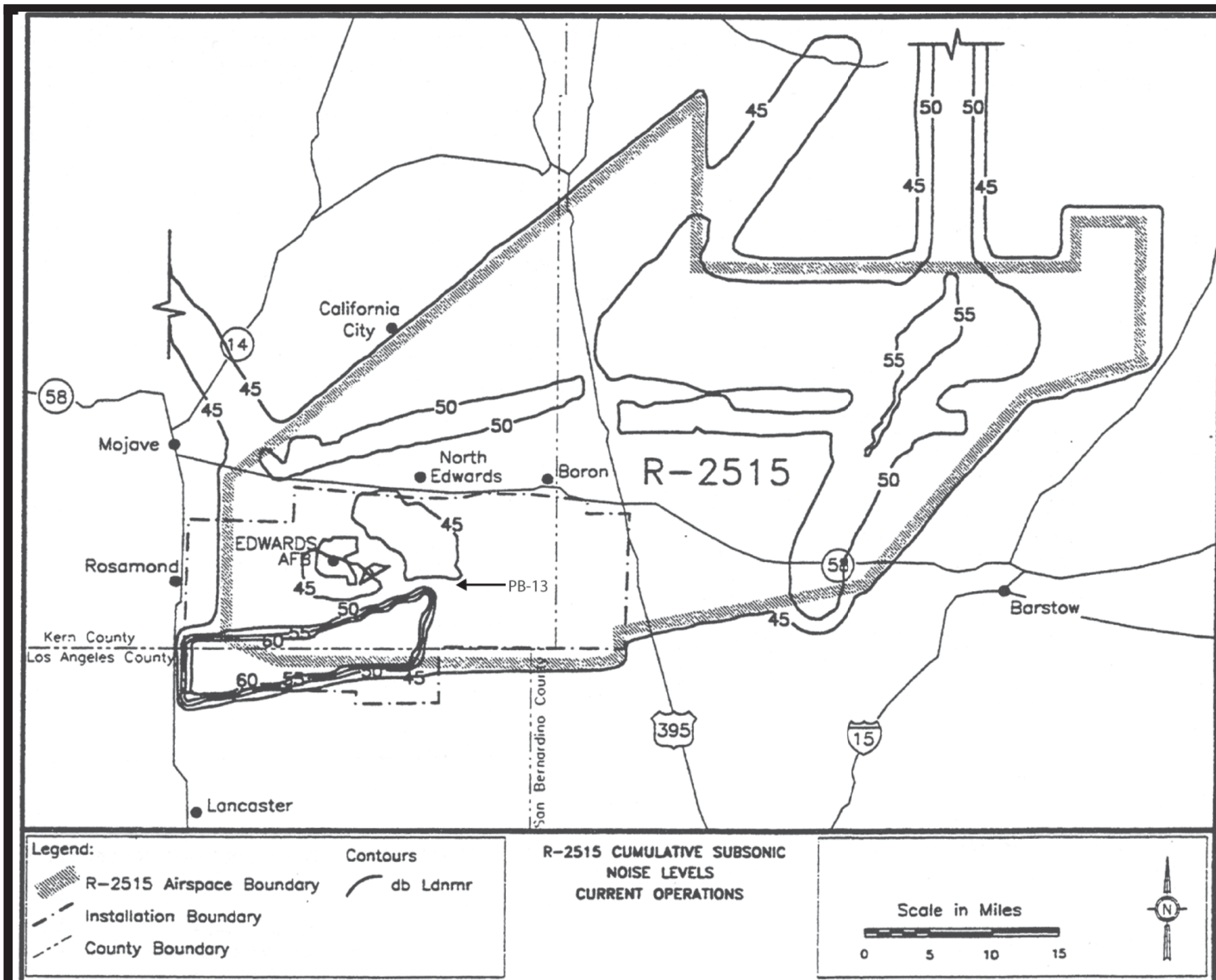


Figure 3-17

Noise Contours Around Runway 04/22 at Edwards AFB

areas. The noise models contained in MR-NMAP assume operations in MOAs and restricted airspace areas are uniformly distributed which accounts for noise contours following the borders of the airspace (Lucas and Calamia 1996).

The total noise contours as shown in Figure 3-18 include the effects of distributed aircraft operations and those of low level and other test routes within restricted area R-2515. The day-night sound levels on the A-weighted dB scale (L_{dn}) noise contours resulting from subsonic aircraft operations in the R-2515 special use airspace, Figure 3-18, show the maximum L_{dn} value of 45 dB along the perimeter of the restricted use airspace. The surface L_{dn} values for most of the interior of the airspace range from 50 to 55 dB. Noise contours for 65 dB and above lie completely within the boundary of Edwards AFB; therefore, ambient noise levels in the areas adjacent to Edwards AFB for Alternatives A, B, and C are anticipated to be below a CNEL of 65 dB under normal conditions (95 ABW and AFFTC 2005). However, there are areas where noise levels exceed 65 dB due to freeways, major highways, airports, and other noise-generating operations. Sensitive noise areas within Regions 1 and 2 under the R-2508 Complex are shown in Figure 3-19. This figure summarizes the noise receptors as associated with land use for national



Source: AFFTC 1995b and Spectrum Sciences

Cumulative Noise Levels for R-2515 Restricted Area	Figure 3-18	Q242-04	1/06/05

and state parks, national forests, recreational areas, cities and incorporated areas including schools, hospitals, and residential areas. Additional detailed information can be found in the *R-2508 Complex Environmental Baseline Study* (95 ABW and AFFTC 2005).

3.11 PUBLIC/EMERGENCY SERVICES

3.11.1 Public/Emergency Services—Region 1

Public/emergency services refer to the capability of ensuring protection of people and property. Public/emergency services at Edwards AFB ensure the protection of base personnel and property. The public/emergency service umbrella at Edwards AFB consists of the Fire Department, Security Forces, and the Medical Group.

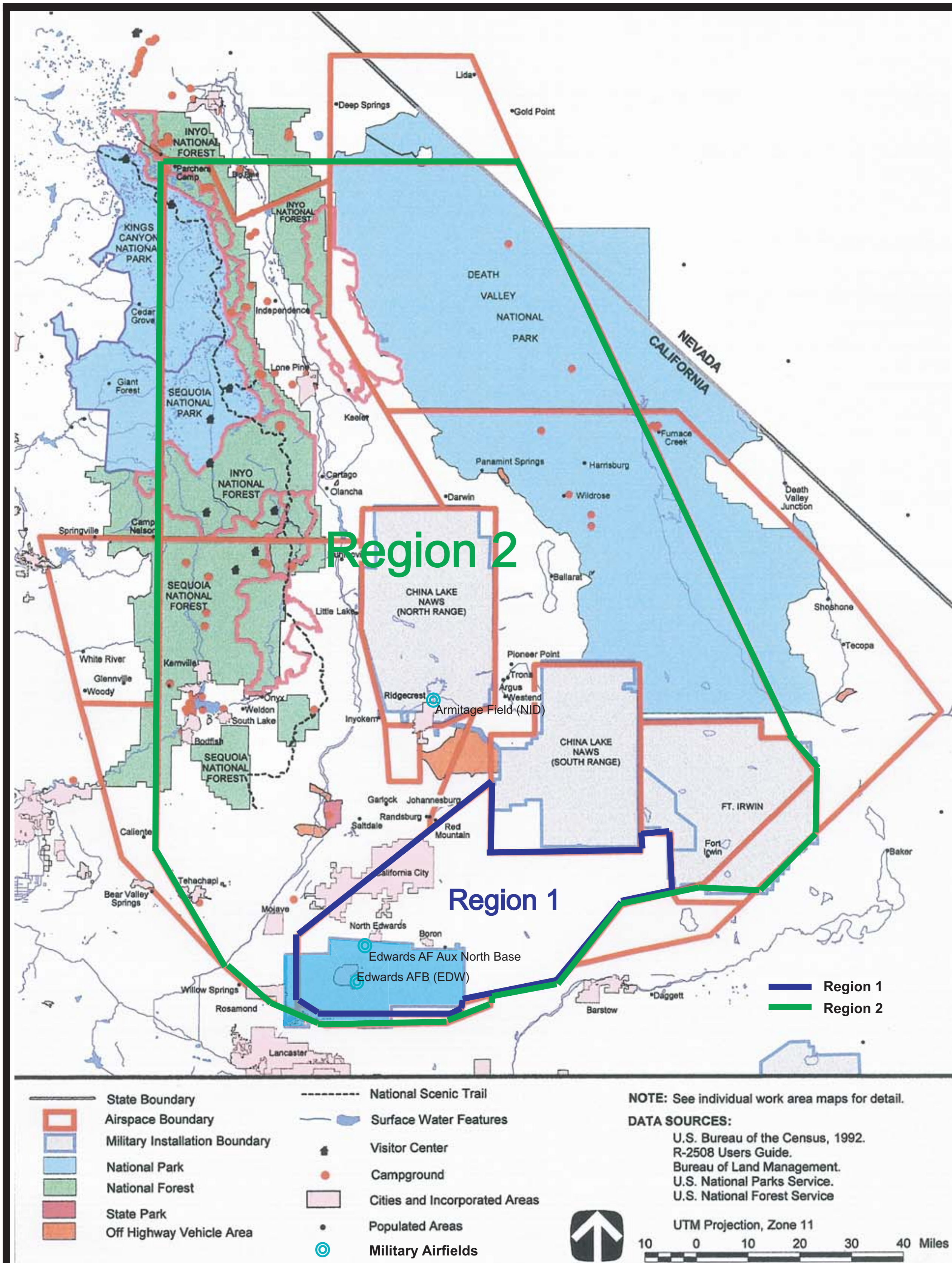
3.11.1.1 Fire Protection/Prevention

Fire protection on Edwards AFB includes trained personnel and equipment organized to respond to a series of emergencies. Guidance for implementing the fire protection and prevention program is outlined in AFFTC Instruction 32-11, *Fire Prevention and Protection Program*. The emergency response time of the Fire Protection Division is contingent upon the distance to the emergency site and the availability of personnel, support equipment, and supplies. All areas of the base are currently covered.

The aircraft supporting laser test and evaluation for Alternatives A, B, and C would utilize Runway 22 for takeoff and landing. This area is located near and serviced by Fire Station No. 1. This station is a 26,200-square-foot facility providing fire protection and emergency medical service as needed for the entire base. Vehicles assigned to this fire station include two engines, five Aircraft Rescue Fire Fighting vehicles, one rescue vehicle, a 5,000- and a 2,000-gallon water tender, and two airfield surveillance vehicles. A maximum of 35 firefighters are housed in this facility.

3.11.1.2 Security

Security forces provide general law enforcement on Edwards AFB. Law enforcement duties include traffic stops, domestic disputes, and police investigations. Security forces (police) include personnel and equipment organized and trained to respond to a series of emergencies, as well as to provide a daily security presence. Security programs provide the means to counter threats during peacetime, mobilization, or wartime.



Noise Sensitive Areas in Regions 1 and 2	Figure 3-19	Q242-04	1/06/05

3.11.1.3 Medical Services

Medical services at Edwards AFB include personnel and equipment that are organized and trained to respond to a series of emergencies. AFI 41-106, *Medical Readiness Planning and Training*, establishes procedures for medical readiness, planning, and training during peacetime and wartime operations.

3.11.2 Public/Emergency Services—Region 2

Public/emergency services within ROI for Alternatives A, B, and C include state and local fire protection services, police, National Guard, and medical/hospital services utilized by the public during accidents, disasters, or events commonly requiring such public/emergency services.

3.12 SAFETY AND OCCUPATIONAL HEALTH

Safety is defined as the protection of workers and the public from hazards. The total accident spectrum encompasses not only injury to personnel, but also damage or destruction of property or products. For worker safety, the boundary of the immediate work area defines the ROI. For public safety, a much larger area must be considered. This area varies depending upon the nature of the operation, but may extend for miles beyond the source of the hazard.

3.12.1 Safety and Occupational Health—Region 1

Potential occupational health and safety issues on Edwards AFB include radiological, biological, chemical, and physical hazards, as well as weapons, flight, ground, range, and test [systems] safety.

The 95th Medical Group/Bioenvironmental Engineering is responsible for industrial hygiene and occupational health. Bioenvironmental Engineering blends engineering and preventive medicine by evaluating and identifying environments that could harm Air Force members, employees, and families. Data from these evaluations are used to help design measures that prevent illness and injury.

The AFFTC's institutional occupational safety program is intended to minimize accidental injury, illness, and loss of property. AFFTC's Safety Office is responsible for monitoring the safety programs through a system of inspections, surveys, audits, and follow-up investigations. Elements of the safety program include accident and injury prevention and reporting, fire prevention and protection, emergency preparedness, and hazardous material and waste management. An Emergency Response Plan is in place to address emergencies such as earthquakes, aircraft accidents, fires and explosions, bomb threats, civil disturbances, nuclear emergencies, and toxic vapor releases or chemical spills. A base-wide safety reporting system encourages employees to report their concerns about workplace safety.

The AFFTC's occupational health program is intended to recognize, evaluate, and control workplace factors or stresses that may cause sickness, impaired health, or significant discomfort to employees. To protect AFFTC personnel from noise hazards, hearing protection is required if personnel are exposed to noise levels exceeding 85 dBA. The program identifies and quantifies worker exposure to hazardous chemicals, noise, and radiation. Through AFFTC's Hazardous Communication Program, employees are educated regarding proper chemical management principles and procedures.

3.12.1.1 Range Safety

The national range system, established by P.L. 81-60, was originally sited based on two primary concerns: location and public safety. Thus, range safety, in the context of national range activities, is rooted in P.L. 81-60 and Department of Defense Directive 3200.11, *Use Management*, *and Operation of Department of Defense Major Range and Test Facilities*; both provide the framework under which the national ranges operate and provide services to range users. To provide for the public safety, the ranges, using a Range Safety Program, ensure that the weapons delivery testing presents no greater risk to the general public than that imposed by overflight of conventional aircraft.

It is the policy of the Edwards AFB Range to ensure that the risk to the public, military personnel, government civilian workforce, contractors, and national resources is minimized to the greatest degree possible. This policy is implemented by using risk management in the areas of public safety, launch area safety, and landing area safety. Range users are required by Edwards AFB to demonstrate, through risk modeling, that the lowest possible risk is achieved, consistent with AFFTC mission requirements and risk guidance. Approval authority for activities using lasers lies with 95th Operations Group, 412 TW, or AFFTC Commander depending on risk level of the test activity. The AFFTC Commander has final authority and responsibility for the safety of the proposed action. The 412TW Commander may deviate from these mission criteria based on geography, weather, and national need; however, the basic standard is no more risk than that voluntarily accepted by the general public in normal, day-to-day activities (NASA 1997b).

Occupational health and safety issues related to aircraft operations (both routine and emergency management) involving ground personnel working near operating aircraft during taxiing and inspection activities, aircrews using runways (lakebed and non-lakebed surfaces), and personnel present during emergency operations, aircraft malfunction, or other mishap are specifically addressed in AFFTC Instruction 11-1, *Air Operations,* and AFFTC Instruction 11-2, *Ground Operations*. These instructions address in-flight operations, flight preparation, and ground procedures directly related to the safety of personnel on the ground, as well as emergency procedures for the protection of all personnel at Edwards AFB.

A fundamental requirement of the Edwards AFB Flight Safety Program is that each unit conducting or supporting flight operations has a flight safety program as well as a Midair Collision Avoidance Program.

3.12.1.2 Exposure Hazards

Non-ionizing Electromagnetic Radiation

Nonionizing electromagnetic radiation (EMR) comes from two major sources: radio frequency emitters (i.e., radars, radar-jamming transmitters, and radio communication equipment), which are regulated by Air Force Occupational Safety and Health (AFOSH) Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*; and laser emitters, which are regulated by AFOSH Standard 48-139, *Laser Radiation Protection Program,* and DoD Instruction 6055.11, *Protection of DoD Personnel from Exposure to Radiofrequency Radiation and Military Exempt Lasers*. Sources of EMR exist throughout the flightline area, and include fixed location radar, airfield management equipment, and aircraft equipment/instrumentation. Electromagnetic radiation can cause thermal and photochemical injuries to humans, particularly to the eyes and skin. Standards and practices are in place to shield and isolate workers from operational hazards of existing EMR sources.

Bioenvironmental Engineering periodically makes visits to and evaluates the operations of all known AFFTC industrial radiation users as a part of the Industrial Hygiene Surveillance Program. This office also verifies (annually) the list of radio frequency radiation emitters and low-powered laser systems used on Edwards AFB. Any proposed use of emitters is evaluated using a preliminary radiation and lasing hazard analysis. Using a permissible exposure limit (PEL) and maximum permissible exposure (MPE), a proper hazard analysis is accomplished. The PEL and maximum exposure limit (MEL) are expressed in terms of safe distance limits from the emitting source. Compliance with these limits is required as a standard operating procedure (AFFTC 1997b).

Lasers

Laser systems such as target range finders and target designators are currently being tested and evaluated at Edwards AFB during aircraft practice sorties. The laser target areas are previously approved locations by the Range Safety Office with laser beam parameters such as the MPE, and the laser beam scatter zones established prior to flight. Scheduling lasing flights are also controlled by the Range Safety Office to minimize the potential of backscatter of the laser beam beyond the ocular hazard zone. Currently, over 50 different types of lasers, including several ANSI Class 3 lasers are approved for testing and use on the PIRA (U.S. Air Force 2003b).

A detailed analysis of laser energy at test ranges is provided as Appendix B. This information was developed specifically for ABL testing. It is applicable for lasing target boards on the Proteus A/A and G/A target and provides calculations that support other aspects of this EA.

3.12.1.3 Maximum Permissible Exposure

The MPE is defined as the level of laser radiation to which a person may be exposed without hazardous effect or adverse biological change in the eye or skin (ANSI Z136.1) The MPE is primarily a function of laser wavelength and exposure duration and will also vary based on pulsed laser output parameters such as pulse width and pulse repetition frequency. Once the MPE has been determined for a laser, the value and the output parameters such as power and divergence or beam spread can be used to determine eye and skin hazard distances. In the ANSI standard the eye hazard distance is referred to as the nominal ocular hazard distance (NOHD). The NOHD is defined as the distance along the axis of the unobstructed laser beam to the human eye where exposure is not expected to exceed the appropriate MPE (ANSI Z136.1).

3.12.1.4 Laser Scattering Effects

The scattering effects of the laser beam are managed from a health and safety perspective by designating nominal ocular hazard zones (NOHZs) for each beam generated. The NOHZ is defined as the space where the level of direct reflected or scattered radiation during normal operation exceeds the applicable MPE (ANSI Z136.1). The NOHZ of a laser system is a laser beam that can point in any direction with no obstruction closer than the applicable NOHD. The NOHZ is represented as a three-dimensional sphere with radius equal to the NOHD. At any point inside the sphere, exposures would be above the applicable MPE. During ground testing, the NOHZ would be represented by a hemisphere or dome extending out into free space above the testing area to an altitude equal to the applicable NOHD. The ground would serve as the impermeable floor of the dome.

In general, a laser beam is attenuated as it propagates through the atmosphere. The laser beam is often broadened and defocused, and may be deflected from its initial propagation direction. The attenuation and alteration depend upon the wavelength of the laser, power output, and general atmospheric conditions. In general, laser light is predominantly scattered forward and backward and relatively little is scattered laterally (AFCEE 2003).

3.12.1.5 Test Range Safety Controls

Laser testing is restricted to authorized and properly trained personnel only, which reduces the possibility of inadvertent (optical) exposure to laser radiation. As specified in laser range standards operating procedures, the range is swept to clear all unauthorized personnel from the area before any outdoor lasing activities take place. In addition to personnel, the range is cleared of materials with mirror-like surfaces (specular) to minimize reflective hazards. Each laser system has established operating procedures to ensure operating safety. Also, safety interlocks associated with laser systems are in place to stop lasing activities if the beam exits the anticipated beam path. Warning signs indicating a laser-controlled area would be posted according to ANSI Z136.1 specifications for the operation of Class 4 lasers. Additional administrative controls are outlined in ANSI Z136.1, *Safe Use of Lasers*, which has been adopted by DoD as the governing standard for laser safety.

Explosives and Propellants

Explosives and propellants are used and stored in a number of locations throughout Edwards AFB. An inhabited building separation distance (or clear zone) has been established around each of the existing explosives and/or propellant use/storage locations. The size of the clear zone varies based on the quantity and type of explosive used, or propellant stored. Clear zones ensure the safety of all personnel in the area from the potential overpressure hazard associated with use and storage of these materials.

3.12.2 Safety and Occupational Health—Region 2

Safety and Occupational Health in areas of Region 2 that are not on military installations is governed by the California Occupational Safety and Health Administration (Cal/OSHA) and Public Safety Programs under the guidance of the California Division of Occupational Safety and Health (DOSH).

Potential occupational health and safety issues in Region 2 include radiological, biological, chemical, and physical hazards.

The Cal/OSHA Program is responsible for enforcing California laws and regulations pertaining to workplace safety and health and for providing assistance to employers and workers about workplace safety and health issues.

The Cal/OSHA Enforcement Unit conducts inspections of California workplaces based on worker complaints, accident reports and high hazard industries. There are 22 Cal/OSHA Enforcement Unit district offices located throughout the state of California. Specialized enforcement units such as the

Mining and Tunneling Unit and the High Hazard Enforcement Unit augment the efforts of district offices in protecting California workers from workplace hazards in high hazard industries.

Other specialized units such as the Crane Certifier Accreditation Unit, the Asbestos Contractors' Registration Unit, the Asbestos Consultant and Site Surveillance Technician Unit, and the Asbestos Trainers Approval Unit are responsible for enforcing regulations pertaining to crane safety and prevention of asbestos exposure.

The Cal/OSHA Consultation Service provides assistance to employers and workers about workplace safety and health issues through on-site assistance, high hazard consultation and special emphasis programs, and develops educational materials on workplace safety and health topics.

The DOSH preserves public safety through its elevator, amusement ride, aerial tramway, and ski lift program as well as its pressure vessel program. The Elevator, Ride and Tramway Unit is responsible for ensuring the public's safety in elevators, permanent and portable amusement rides, and aerial tramways and ski lifts. The Pressure Vessel Unit ensures the safe operation of boilers, air tanks, and other types of pressure vessels.

Radiological Hazards

The Radiological Health Branch is within the Food, Drug, and Radiation Safety Division of the Department of Health Services. The Branch enforces the Radiation Control Laws and Regulations designed to protect the public, radiation workers, and the environment. It is responsible for providing public health functions associated with administering a radiation control program. This includes licensing of radioactive materials, registration of X-ray-producing machines, certification of X-ray and radioactive material users, inspection of facilities using radiation, investigation of radiation incidents, and surveillance of radioactive contamination in the environment.

3.13 SOCIOECONOMICS

Socioeconomic resources are the economic, demographic, and social assets of a community. Key elements include fiscal growth, population, labor force and employment, housing stock and demand, and school enrollment.

3.13.1 Socioeconomics—Region 1

Edwards AFB makes a substantial contribution to the economic status of the surrounding communities within the Antelope Valley. The Antelope Valley has a labor force of approximately 161,031 persons with an unemployment rate of 13.6 percent. The labor force is employed in a variety of industries including services, manufacturing, construction/mining, retail, government, and agriculture. The military labor force comprised two percent and the government labor force comprised six percent of those employed in the Antelope Valley in 1997 (Alfred Gobar Associates 1997). As of March 31, 1999, Edwards AFB employed approximately 10,920 military, civilian, and contractor personnel.

Edwards AFB provides permanent party housing for military members in the form of dormitories, military family housing, and mobile home park spaces. Edwards AFB has an approximate total of 1,741 housing units with an occupancy rate goal of 98 percent. The number of housing units fluctuates due to the demolition of older units and construction of new units. The number of units ranges from 1,640 to 1,777. Edwards AFB also maintains a 188-space mobile home park for privately owned mobile homes. Personnel with families and unaccompanied members are allowed to reside in the park (MARCOA Publishing, Inc. 1998).

Unaccompanied enlisted members and designated key and essential personnel are required to live on base. Edwards AFB has two- and three-story dormitories, each housing from 32 to 84 members in single and double rooms. A new complex with single rooms has recently been opened. Transient quarters are available through the Billeting Office.

Edwards AFB has three elementary schools and one junior/senior high school, both under the jurisdiction of the Muroc Unified School District. The 1998 to 1999 school year enrollment for these schools was 385, 346, and 457, respectively. The 1998 to 1999 school year enrollment for Desert Junior/Senior High School was 626 (Muroc Unified School District 2004).

Several additional school districts exist within the Antelope Valley. According to the California Department of Education, total enrollment in these school districts for the 1998 to 1999 school year was 128,029. Numerous private schools also exist within this region.

In fiscal year 1998, Edwards AFB expended $3,186,230 for training and education of active duty personnel and civilians. Impact Aid provided by the Department of Education to school districts that are associated with Edwards AFB was $4,631,541 for fiscal year 1998. This aid is provided to schools attended by children who reside on-Base or whose parents work on-Base, or both. These parents may be active duty military or civilians (Levell 1999).

3.13.2 Socioeconomics—Region 2

The population in Region 2 is sparse. Many of the sparsely populated areas in the R-2508 Complex are part of national parks, national forests, or other recreation areas. Cities range in size from a small city such as Boron with a population of 2,025 to Ridgecrest with a population of 24,927 (U.S. Census Bureau 2000). Four of the most important job categories include public administration; educational, health, and social services; retail trade; and professional, scientific, management, administrative, and waste management services (U.S. Census Bureau 2000). The three military installations in the R-2508 Complex also contribute significantly to the employment in nearby communities.

3.14 WATER RESOURCES

This section describes the surface water and groundwater resources including their source, quantity, and quality.

3.14.1 Water Resources—Region 1

3.14.1.1 Water Quantity and Source

Jurisdictional waters of the United States do not occur within Edwards AFB (USACE 1996). Non-jurisdictional water resources at Edwards AFB include groundwater, water from the AVEK Water Agency, storm water drainage/flood-prone areas, treated wastewater effluent, artificial ponds supporting aquatic habitat and recreation, dry lakes, and ephemeral streams. The AFFTC purchases potable water from the AVEK Water Agency through a water distribution system located in Boron, California. Treated wastewater effluent is used for some urban landscape irrigation and feeds some artificial ponds (Edwards AFB 2002).

The Antelope Valley is a single, undrained, closed basin. The principal source of recharge to the aquifer system in the Lancaster subbasin is infiltration of rainfall runoff through alluvial fans of creeks flowing off the San Gabriel Mountains on the southern boundary of the Antelope Valley (Edwards AFB 2002). Recharge from infiltration in the hills on the eastern and northwestern parts of the Edwards AFB area is minimal because precipitation is low and evaporation is high. Major faults that cut through the alluvial deposits in the Antelope Valley act as partial barriers to the movement of groundwater. Water-level differences of more than 300 feet in the same aquifer may be present. Storm water may enter the groundwater directly through giant desiccation cracks and fissures, but this is considered to be a small source of recharge because of the low permeability of the lakebed surface (Edwards AFB 2002).

Groundwater has been an important source of water for the Antelope Valley since development began there in the late 1800s, and for the base since 1947. In recent years of rapid urban growth and drought, between 50 and 90 percent of all water demands in the Valley were satisfied by groundwater. Groundwater pumping and irrigation of crops began to decrease when water levels declined. Groundwater depth has declined approximately 90 feet since 1947 (AFFTC 1999). Edwards AFB uses 15 groundwater wells, 10 of which are reserved for drinking water purposes (Edwards AFB 2002). South Track, near the southern boundary of Rogers Dry Lake, has eight of the wells in production and taps the deep aquifer to provide potable water to the main Base. The 10 potable water wells have a maximum combined production capability of 15.6 mgd (Edwards AFB 2002).

3.14.1.2 Water Quality

The U.S. EPA's Office of Water establishes the groundwater and drinking water quality standards found in the National Primary Drinking Water Regulations (or primary standards) that are legally enforceable and apply to public water systems. Edwards AFB must also conform to standards for clean water set by the California Department of Health Services. The Lahontan Regional Water Quality Control Board and California Department of Health Services, Southern California Field Operations Branch, Tehachapi District, administer these standards locally. Primary standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in public water systems. The Bioenvironmental Engineering Office monitors base groundwater quality, and compliance with drinking water standards.

Because of the history of the PIRA and its size, past practices may have contributed to soil and/or groundwater contamination. In the past, ranches, homesteads, and mining operations were prevalent in the Antelope Valley including the area that is now within PIRA boundaries. Past activities on the PIRA may have included improper storage, disposal and/or burial of solid or hazardous materials. Section 3.6 describes the environment with respect to identified hazardous materials that have the potential to contribute to soil or groundwater contamination.

3.14.1.3 Storm Water Drainage/Flood Prone Areas

Edwards AFB is situated at the bottom of Antelope Valley Watershed Basin, roughly a 2,400 square mile watershed with no outlet. Rainfall in the San Gabriel Mountains southwest of Edwards AFB, and in the Tehachapi Mountains northwest of the Base, drains in relatively well-defined streams toward the valley.

The streams flow to the valley floor and transition to an overland sheet flow pattern. Sediment deposition has resulted in the following landforms:

- Transitional alluvial fans nearest the mountains with loamy, sandy, and gravelly sediments of high permeability;
- Desert plateaus toward the middle of the valley with sandy and silty sediments of intermediate permeability; and
- Playa lakebeds at the central low points of the valley with silty and clayey sediments of low permeability.

There are no perennial streams on Edwards AFB. Storm water runoff for the entire watershed is directed toward three large playa lakebeds: Rogers, Rosamond, and Buckhorn Dry Lakes. Playas are expansive, ancient dry lakes that fill with water during the rainy season. Water may be retained in these playas for several months due to mostly impermeable, alkaline, saline soils that contain high levels of solute, sodium, and total dissolved solids. Any water reaching these lakebeds is trapped and subsequently evaporates (Edwards AFB 2002; USGS 1998).

In general, drainage tends to flow toward the nearest dry lakebed. Rosamond and Buckhorn Dry Lakes, in turn, drain towards Rogers Dry Lake (AFFTC 1993). Water level elevations for Rosamond Dry Lake during flood conditions are shown in Table 3-17 (USACE 1996).

Table 3-17

Water Level for Rosamond Dry Lake Flooding Events

Flood Level	Lake Elevation (feet above MSL)
50-year	2,280.9
100-year	2,282.2
200-year	2,283.4

Despite the apparent potential for the formation of a sizable lake, the playa lakebeds remain dry most of the time due to arid climate conditions. The average annual rainfall at the base is approximately 5 inches; the maximum recorded 1-year rainfall was 15.5 inches, which occurred in 1983. The average annual evaporation, as measured by a nearby Mojave pan evaporation gauge from 1939 to 1959, is 11.4 inches.

The Mojave Creek Floodplain is a well-defined drainage that runs southeast along the north and east of the residential area of Main Base along Lancaster Boulevard, and crosses Rosamond Boulevard where it runs southward just west of South Base and empties into Rogers Dry Lake. Mojave Creek is dry for most of the year, but periodic flooding does occur during above-normal rainfall periods (AFFTC 1993). Per the base *Stormwater Pollution Prevention Plan* (September 1998), the storm water collection system consists of drainage ditches (flowing east to Rogers Dry Lake) and storm water retention ponds (located on the west edge of Rogers Dry Lake) (Edwards AFB 2002).

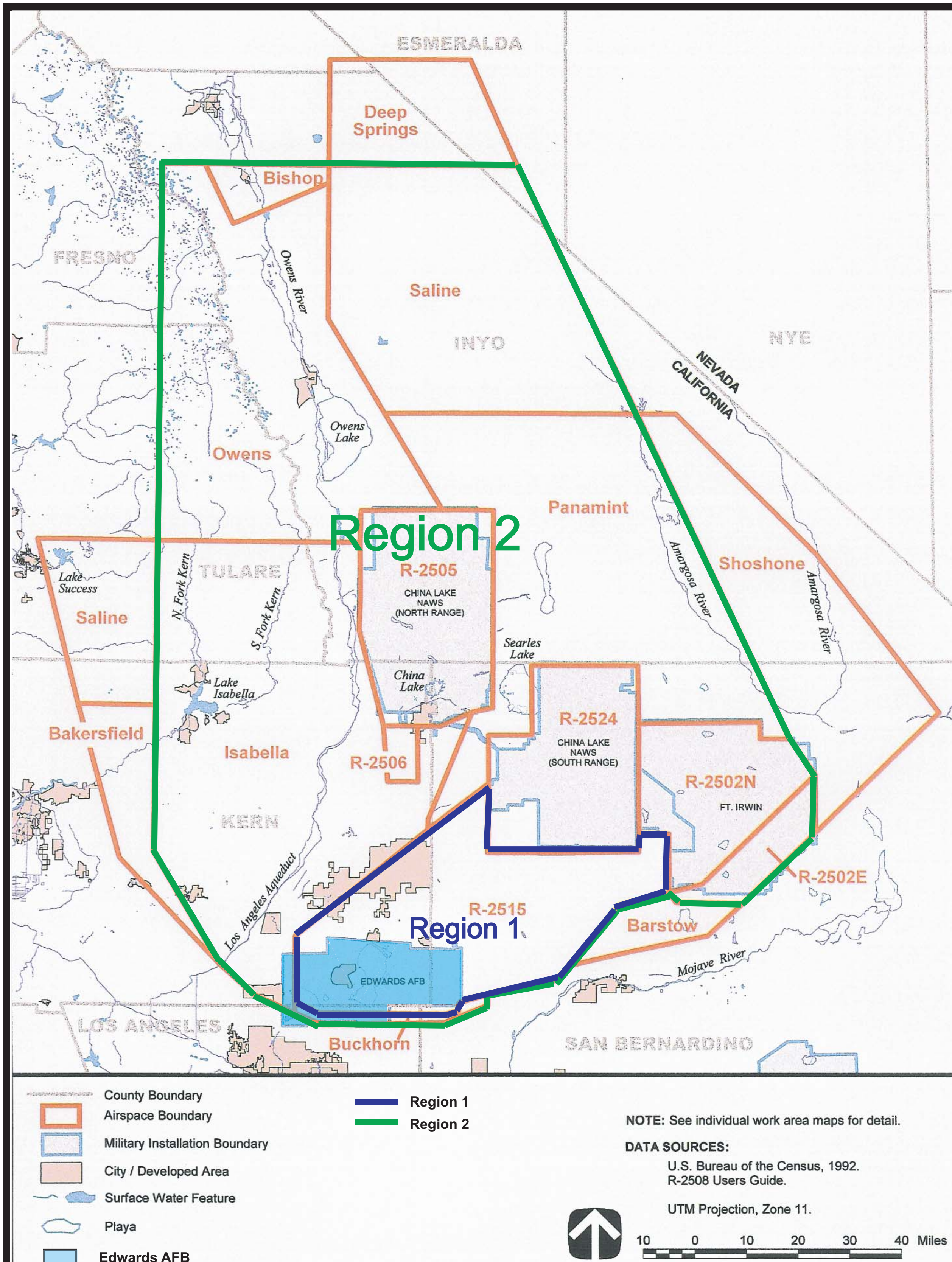
In 1993, a flood study of the Base was conducted to determine floodplain constraints (AFFTC 1993). Rogers Dry Lake, Rosamond Dry Lake, and Mojave Creek (which empties into Rogers Dry Lake) were identified as the most critical flood-prone areas. A small portion of Rogers Dry Lakebed extends into the PIRA along the Mercury Boulevard/West Range boundary in the North Flank areas. Other flood-prone areas on Edwards AFB occur in the residential area, where no channels are present to divert heavy storm water runoff.

The AFFTC 1993 flood study estimated a flood-of-record inundation elevation to be used for planning purposes and performed a risk of flooding analysis of existing base facilities near Rogers Dry Lake. This level represents the maximum water surface elevation that would occur during a flood of reasonably high return interval (e.g., 50 years, 100 years). The level of flooding that occurred in 1943 was estimated to be the flood-of-record level. Most development on Edwards AFB is above this estimated flood-of-level of 2,277.4 feet (North American Vertical Datum of 1988). Only a small portion of the NASA ramp and North Base are affected. Relatively high flooding in 1993 remained more than 3 feet below the estimated flood-of-record level (AFFTC 1993).

3.14.2 Water Resources—Region 2

A detailed discussion of water resources underlying the R-2508 Complex is provided in the *R-2508 Complex Environmental Baseline Study* prepared in 1997 and updated in 2005 (AFFTC 2005). This discussion of Region 2 water resources is summarized from that section. Figure 3-20 shows water resources in Region 2, specifically under the lateral boundaries of the R-2508 Complex. Several bodies of water and dry lakes underlie the R-2508 Complex and are used for a variety of purposes including water supply (e.g., irrigation, domestic and municipal purposes), recreational uses, and aircraft landing areas. The Los Angeles Aqueduct, which conveys water to agencies in Southern California, is located within the Complex boundaries. This portion of the aqueduct extends north from the southern boundary of the Isabella Area to the Hiawee Reservoir near the southern boundary of the Owens Area.

Major surface waters underlying the R-2508 Complex include the Tinemaha Reservoir, North and South Forks of the Kern River, Lake Isabella, Owens River, and the Amargosa River. Major playas located in the complex include Owens Lake, Rogers Dry Lake, Rosamond Dry Lake, Searles Lake, and China Lake.



Water Resources in Regions 1 and 2	Figure 3-20	Q242-04	1/06/05

Four rivers in the R-2508 Complex have been designated as Wild and Scenic Rivers; these are the North Fork Kern River, the South Fork Kern River, the South Fork Kings River, and the Kings River.

R-2515 Area. The R-2515 Area overlies the Antelope Valley and Mojave Desert. Runoff from the two large watersheds in this area is deposited into four major dry lakes in the region: Rogers and Rosamond Dry Lakes within Edwards AFB, Harpers Dry Lake, and Cuddeback Lake.

Saline and Deep Springs Areas. A major portion of the Saline and Deep Springs Areas is within the boundaries of Death Valley National Park, which has an average annual rainfall of less than 2 inches. With the exception of infrequent cloudbursts, the majority of water currently supplied to the Death Valley area is derived from mid-elevation springs dependent on regional groundwater flow systems.

Isabella and Porterville Areas. Surface waters in the Isabella Area include the North and South Forks of the Kern River, Lake Isabella (a man-made lake), and the Los Angeles Aqueduct. The North and South Forks of the Kern River join at Lake Isabella to form the Kern River, which flows southwest to the City of Bakersfield. A portion of Rosamond Dry Lake is located in the southeastern portion of the Isabella Area. Lake Success is in the northwest corner of the Porterville Area.

Panamint and Shoshone Areas. A major portion of these areas is within Death Valley National Park; surface water resources within these areas are scarce and no perennial watercourses dominate the region. Searles Lake, a dry lake, is located in the eastern portion of the Panamint Area.

Barstow Area. Located in the eastern portion of the Mojave Desert, the surface water resources within the Barstow Area are scarce and no perennial watercourses dominate the region.

R-2505, R-2506, and R-2524 Areas. Land area is divided into the North Range and the South Range, and springs are the dominant water source. Playas in the North Range, including China Lake, are usually relatively smooth and hard except where ephemeral rains drain into them.

R-2502N/R-2502E Areas. Surface water resources within these areas are scarce as the areas are located within the eastern portion of the Mojave Desert. However, hydrologic features are varied and include springs, seeps, ephemeral streams, and playas. No perennial watercourses dominate the region.

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4.0 ENVIRONMENTAL CONSEQUENCES

This chapter discusses the potential environmental consequences or impacts associated with Alternatives A, B, and C. Changes to the natural and human environment that could result from Alternatives A, B, and C were evaluated relative to the existing environmental conditions described within Chapter 3.0.

This EA only addresses the impacts associated with testing and evaluation of DE systems using laser technology. While this analysis looks at the effects of the Proposed Action and Alternatives, it does not cover other types of DE devices or other segments of the laser technology life cycle. Analysis of other phases (e.g., weapons design and development, production, transportation) will be the responsibility of the intended test program office; separate environmental documentation would be required under these phases of the program. The environmental consequences for this EA are based on the assumption that ground and airborne targets would be physically located within the land surface area (Management Areas A through G) and airspace identified as Edwards AFB (see Figure 2-3). Aircraft and other airborne platforms could either be located in the airspace above Edwards AFB, within restricted area R-2515, within the R-2508 Complex, or above the NAS for communications lasers.

During most laser test and evaluation missions, the duration of lasing to ground or airborne targets will normally be between 0.1 and 10 seconds; however selected tests may require lasing activities longer than 10 seconds. According to a report titled, *Laser Options for National Missile Defense*, it would take 4 to 6 seconds for a laser kill by the beam radiating the missile's skin (on a 0.3-centimeter steel skin for a No Dong missile[1]) (Leonard 1998). These longer lasing times may be required to penetrate steel and armor plated targets.

In general, impacts described in this chapter address normal operations and use of laser technology in a controlled test and evaluation environment. Potential impacts are described for flight test activities (A/A, A/G, and G/A modes) and ground test activities (G/G mode).

[1] The longest range missile currently deployed by North Korea is the No Dong missile, which has an estimated range of 1,300 kilometers with a payload of about 700 kilograms. Such a range would allow North Korea to target all of Japan. North Korea is believed to have flight tested the No Dong missile only once—in May 1993. The No Dong missile uses a larger, more powerful engine than the Scud missile. This engine, which is believed to have been developed with foreign assistance, is thought to be used in the longer range missiles North Korea is developing.

4.1 AIR QUALITY

The following evaluation was prepared for emission impacts from aircraft based on 60 flight missions in 2006, 70 flight missions in 2007, 140 flight missions in 2008, and 169 flight missions each in 2009 and 2010. Each mission would consist of one test aircraft and one chase aircraft. One-third of the missions would include the emissions from the Proteus airborne target. Emissions from AGE and ground support equipment (GSE) were also estimated and included in the total emissions resulting from test flights for each projected year of testing. Emissions from ground tests were estimated by assuming 24 G/G laser test missions per year. Emissions from testing communication lasers would be included as part of the G/A mode. Any emissions during laser communications testing above 3,000 feet AGL would be treated the same as other emissions created during flight test activities.

4.1.1 Alternative A (Desired Capability, Proposed Action Alternative)

Alternative A would be to conduct low, medium, and high power laser testing within Region 1 and Region 2 in the G/G, G/A, A/G, and A/A modes. Communication lasers, in addition to being tested in the G/G, G/A, A/G, and A/A modes, would be tested at low, medium, and high power settings in G/S, S/G, A/S, and S/A modes. The following summarizes sources of potential emissions from various testing activities associated with Alternative A.

4.1.1.1 Air Quality–Region 1

Emissions occurring in Region 1 include those released on the ground and in the air while operating within the boundaries of restricted area R-2515. Based on the conformity applicability screening analysis presented in Section 4.1.4, air emissions created during flight and ground test activities are less than significant. No mitigation would be required as a result of implementing Alternative A.

Flight Test Activities

Flight test activities would consist of one landing and takeoff (LTO) event for test aircraft, and LTO and touch and go (TGO) events for chase aircraft. Typically, only emissions released from aircraft below 3,000 feet AGL are considered for their potential effects to air quality. Emissions from aircraft operating in airspace above 3,000 feet AGL were not considered. These emissions (1) would be released above the mixing height and effectively blocked from dispersion to the surface or (2) would be released from such a height and over such a vast area that ground-level concentrations resulting from downward dispersion would be negligible. Estimated emissions from the test aircraft are summarized in Section 4.1.4 and were included in the conformity applicability screening analysis.

Each mission would require, in addition to the laser test and evaluation and chase aircraft, additional AGE and GSE to effectively carry out the test plan. This equipment includes the generators necessary to prepare aircraft for take-off and the equipment for loading/unloading necessary system components and cargo. If an airborne target similar to the Proteus aircraft was used, then air emissions from its engines would be included. These emissions are summarized in Section 4.1.4 and were included in the conformity applicability screening analysis.

Additional emissions would be generated as a result of lasing while in flight. Typical gaseous emissions expected from a typical single HEL mission using a COIL and operating under normal conditions are shown in Table 4-1. Although these emissions are summarized below, because it is assumed that test aircraft would be above 3,000 feet AGL when lasing for 95 percent of the events, the emissions were not included in the emission summary prepared for the conformity applicability screening analysis.

Table 4-1

Estimated High Energy Laser Gaseous Emissions (per mission)

Chemical	Quantity (pounds)	Concentration in Mixing Volume (part per million)
Ammonia	179	0.0117
Carbon dioxide	873	0.0220
Chlorine	79	0.0012
Helium/Nitrogen	238	0.0378
Hydrogen	51	0.0564
Iodine	28	0.0001
Oxygen	595	0.0207
Water	1190	0.0735

Source: U.S. Air Force 1997.

Laser testing in the high power setting could create laser generated air contaminants (LGACs). The quantity, composition, and chemical complexity of LGACs depend greatly on beam irradiance. When the target irradiance reaches a given threshold, approximately 10 megawatts per square centimeter (MW/cm^2), target materials, including plastics, composites, tissue, and metals may liberate toxic and noxious airborne contaminants. Air contaminants can be generated when certain Class 4 laser beams interact with matter (ANSI 2000a). LGACs would not be created during low-power testing. Target boards would be equipped with infrared sensors used to detect the laser beam(s). Sensor data would be transmitted electronically to the test command and control center. The controlled access to the remote target areas in Region 1 would further reduce the potential for LGACs to create any significant impact.

Emissions can also be expected as a result of lasing targets while in flight (the A/A and A/G modes). It is expected that these tests would take place above 3,000 feet AGL for all but 5 percent of the events, and would therefore, have no impact on air quality. Based on the data from the conformity applicability screening analysis (see Section 4.1.4) annual air emissions from laser test events would be 80 to 95 percent below *de minimis* thresholds. Consequently, the emissions were not included in the conformity applicability screening analysis.

Ground Test Activities

Ground testing activities that would generate air emissions in addition to those currently generated at Edwards AFB include developmental laser testing in the G/G and G/A modes as applicable to the various systems being tested. On-ground testing of space-based laser systems in the G/S mode would focus on communications-related systems.

In the G/G, G/A, and G/S modes, emissions would be generated from the ground platform the laser is mounted on (such as the hybrid diesel/electric Hummer [high mobility multi-wheeled vehicle or HMMWV]) when moving to an FP. Emissions expected to be generated from the vehicle used for the G/G, G/A, and G/S modes are summarized in Section 4.1.4 and have been included in the conformity applicability screening analysis. Total emissions for project aircraft, target platforms, and ground equipment would range from 6 percent to 40 percent of the *de minimis* threshold values for all constituents. The low power used for the communication lasers is not expected to create emissions at the ground target.

Other potential air emissions would include those resulting from lasing targets in the G/G and G/A modes by platforms that normally would be used for A/A or A/G modes (e.g., ABL and AC-130). Target materials could include aluminum, steel, composites, or other alloys. There is no common method for estimating the emissions generated from lasing a target based on target composition. However, the effect of lasing the target material would be similar to lasing these materials during the commercial applications (i.e., using a laser for fine cutting of target materials). Lasing would last less than 10 seconds per event.

These emissions have not been quantified and were not included in the conformity applicability screening analysis. These emissions would contribute to total project emissions; however the quantity of the emissions is expected to be extremely low and readily dispersed by a prevailing southwest wind.

Because the air emissions from the project aircraft, target platforms, and ground equipment would be below *de minimis* thresholds (see Table 4-3 in Section 4.1.4) and air emissions created while lasing the targets would also be expected to be very low (Table 4-1), significant impacts on air quality would not be anticipated if Alternative A was implemented in Region 1.

4.1.1.2 Air Quality–Region 2

The only emissions from laser test activities in Region 2 would be those released in the air while operating outside of Region 1 but within the boundary of the R-2508 Complex. Since air emissions created by test and chase aircraft would not result in significant impacts on air quality in Region 2, no mitigation would be required as a result of laser test and evaluation flight test activities under Alternative A in Region 2.

Flight Test Activities

Air emissions in Region 2 as a result of test and evaluation activities would originate from test aircraft and chase aircraft. Since the targets would be located on Edwards AFB for the A/G and S/G modes or in the airspace above Edwards AFB for the G/A, S/A, and A/A modes, there would be no emissions from targets in Region 2. Emissions from lasers similar to the COIL laser as cited in Table 4-1 would also occur for Region 2 laser test and evaluation events. The laser would not be fired during all flight test activities; thus emissions from the laser would not necessarily occur for every mission. It is assumed that flight test activities would occur above 3,000 feet AGL except for approximately 5 percent of the events and, therefore, would not contribute to the deterioration of air quality below the mixing zone.

Ground Test Activities

Laser testing in the A/G, G/G, G/S, and S/G modes would not be conducted in portions of Region 2 outside of Region 1. Since all ground test related air emissions would occur in Region 1, no air emission mitigation would be required for ground test activities in the portion of Region 2 that does not include Region 1.

4.1.2 Alternative B (Limited Capability)

Because Alternative B is similar to Alternative A, similar emissions would be expected. The proposed activities under Alternative B are to conduct only low power laser testing within the boundaries of Region 1 and the R-2508 Complex for the G/G, G/A, A/G, and A/A modes. The number of flight tests conducted would be the same as under Alternative A. Medium and high power tests would still be conducted but would be limited to test facilities and controlled areas of Edwards AFB. Communication lasers would only be tested in the low power setting for G/S, S/G, A/S, and S/A modes within the boundaries of the R-2508 Complex and Edwards AFB and at medium and high power inside test facilities and controlled areas on Edwards AFB. LGACs would not be created during low-power testing. For both Alternatives A and B, air emission evaluations and estimates are calculated based on expected laser platform equipment operation as opposed to operating only the lasers. Therefore, emission estimates are independent of laser power settings and the expected emissions for Alternative B would be similar to those of Alternative A. No differentiation was made when performing the conformity applicability screening analysis.

4.1.2.1 Air Quality—Region 1

Under Alternative B, air emission impacts in Region 1 would be similar to those identified under Alternative A and would be less than significant. No mitigation would be required.

4.1.2.2 Air Quality—Region 2

Under Alternative B, air emission impacts in Region 2 would be similar to those identified under Alternative A and would be less than significant. No mitigation would be required.

4.1.3 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, the operational laser testing would continue based on the *Final Environmental Impact Statement for the Program Definition and Risk Reduction Phase of the Airborne Laser Program* (U.S. Air Force 1997) and *Supplemental Environmental Impact Statement for the Airborne Laser Program* (AFCEE 2003); no additional air emissions would be generated. No additional mitigation measures beyond those described in these two environmental impact statements would be required if Alternative C were implemented.

4.1.4 Conformity Applicability Screening Analysis

Because air pollutant emissions would be expected to be similar for both Alternatives A and B, they were evaluated simultaneously in the following conformity applicability screening analysis. In addition, because pollutants emitted above 3,000 feet AGL were determined to be insignificant and emissions in Region 2 would occur above this mixing layer, except for up to 5 percent of the flight tests, the conformity applicability screening analysis only considered emissions in Region 1.

Sources of emissions generated under Alternatives A and B would include

- Privately owned vehicles of current on- or off-Base Air Force or contractor personnel required for temporary duty for weapons support;
- One LTO for one laser-equipped aircraft;
- One LTO and one TGO for one chase aircraft during test and evaluation events;
- AGE; and
- GSE used for loading and unloading laser components (consisting of 1 light-duty gasoline vehicle, 1 light-duty gasoline truck, 1 heavy-duty gasoline truck, and 1 light-duty diesel truck).

Emissions from representative platforms such as the ABL (Boeing 747), AC-130, B1-B, H-47, MV-22, F-22, F-35, UAV, Proteus, T-38, F-15, and F-16 aircraft were considered in the conformity calculations. The ABL (Boeing 747), AC-130, B1-B, H-47, MV-22, F-22, F-35, and UAV aircraft or platforms with similar characteristics would be used as the platform conducting the laser test and evaluation operations, and platforms similar to the T-38, F-15, and F-16 would be used as chase aircraft (primarily for data collection). The Proteus aircraft or other target similar to the Proteus would be the only airborne target creating air emissions. Projected aircraft utilization for the laser test and evaluation events is shown in Table 4-2.

Since there would be no new construction or specialty equipment required, the actual emissions resulting from and assessed under Alternative A would occur primarily from privately owned vehicles, test and evaluation and delivery aircraft, AGE, and GSE.

Table 4-2

Project/Chase Aircraft Utilization for Laser Test and Evaluation

Type of Event Support	Percent Utilized
Test Aircraft	
ABL Boeing 747	36
AC-130	13
B1-B[1]	3
F-22	6
F-35	12
H-47	13
MV-22	7
UAV	13
Chase Aircraft	
F-15	36
F-16	37
T-38	27
Target Aircraft	
Proteus[2]	33

Notes: 1 – B1-B would not be a test platform until 2009.
2 – The Proteus aircraft would be the only aircraft targeted over Edwards AFB for laser test and evaluation missions. For evaluation purposes approximately 33 percent of the missions would involve the Proteus aircraft.

Source: Hagenauer 2005.

Laser test and evaluation aircraft flights are anticipated to be 1 to 3 hours in duration with approximately 5 percent of that time spent below 3,000 feet AGL. Emissions from test and evaluation aircraft LTOs and flights were calculated using engine emission factors specific to each potential engine and engine-operating mode (Air Force Institute for Environmental, Safety and Occupational Health Risk Analysis [AFIERA] 2002). Engine emission factors were multiplied by:

- The total number of operations expected to occur per test and evaluation event;
- The number of engines operating during a particular operation;
- The time in each engine mode and expected fuel flow for the particular operation; and

- The estimated amount of time the flights are expected to be below 3,000 feet AGL.

The AGE/GSE emissions were calculated using emission factors obtained from *AP-42: Compilation of Emission Air Pollutant Factors* (U.S. EPA 2000) and Air Force Institute for Environmental, Safety and Occupational Health Risk Analysis (AFIERA 2002). AGE emissions were calculated based on the number of missions per year, phase of each mission, and the type of aircraft being supported. GSE emission calculations were performed utilizing duration of activity or miles driven and vehicle engine emissions for the given size ground transport vehicles.

The vehicle emissions from current on- or off-base Air Force or contractor personnel required for temporary duty for laser testing events are not evaluated in this analysis because they are exempt under 40 CFR 51.853(c)(2)(vii) and (x). Only vehicle emissions generated as a direct result of project activities were considered. The routine, recurring transportation of personnel and the future activities conducted would be similar in scope to those currently being conducted at existing facilities. This would result in no emissions increase or emissions that are clearly *de minimis*. Therefore, those actions (transportation of personnel in this case) are exempt.

The total project emissions for aircraft, AGE, and GSE for typical laser test and evaluation events under Alternatives A and B are summarized in Table 4-3. Details of the emission calculations from each activity are provided in Appendix A.

Table 4-3

Conformity Applicability for Total Emissions Sources Associated with Alternatives A and B

Emission Source	NO_2	VOC	PM_{10}	SO_2	CO
Year: 2006 (60 Air/24 Ground Missions)					
Aircraft LTOs/TGOs[a] (60 flights)					
Test and Evaluation Mission Aircraft ABL (Boeing 747), AC-130, H-47, F-22, MV-22, and UAV	2.026	0.604	0.521	0.010	2.323
Chase Aircraft (60 flights) T-38, F-15, and F-16	0.862	0.172	0.110	0.005	1.161
Target Aircraft[a] (20 flights) Proteus	0.022	0.004	0.011	0.000	0.052
Aerospace Ground Equipment	0.171	0.004	0.015	0.012	0.012
Ground Support Equipment	0.094	0.154	1.024	----	1.178
Ground Platform Test and Evaluation (24 missions)	0.0013	0.0010	0.0021	0.0002	0.0017

Table 4-3, Page 1 of 3

Table 4-3

Conformity Applicability for Total Emissions Sources

Associated with Alternatives A and B (Continued)

Emission Source	NO_2	VOC	PM_{10}	SO_2	CO
Year: 2007 (70 Air/24 Ground Missions)					
Aircraft LTOs/TGOs[a] (70 flights)					
Test and Evaluation Mission Aircraft ABL (Boeing 747), AC-130, H-47, F-22, MV-22, and UAV	2.195	1.007	0.563	0.012	3.238
Chase Aircraft (70 flights) T-38, F-15, and F-16	0.992	0.199	0.128	0.006	1.357
Target Aircraft[a] (23 flights) Proteus	0.026	0.005	0.013	0.000	0.060
Aerospace Ground Equipment	0.190	0.005	0.017	0.014	0.013
Ground Support Equipment	0.109	0.180	1.194	----	1.375
Ground Platform Test and Evaluation (24 missions)	0.0013	0.0010	0.0021	0.0002	0.0017
Year: 2008 (140 Air/24 Ground Missions)					
Aircraft LTOs/TGOs[a] (140 flights)					
Test and Evaluation Mission Aircraft ABL (Boeing 747), AC-130, H-47, F-22, MV-22, and UAV	4.390	2.014	1.126	0.023	6.477
Chase Aircraft (140 flights) T-38, F-15, and F-16	2.714	0.398	0.255	0.012	2.714
Target Aircraft[a] (47 flights) Proteus	0.053	0.010	0.027	0.001	0.122
Aerospace Ground Equipment	0.381	0.009	0.033	0.028	0.026
Ground Support Equipment	0.218	0.360	2.389	----	2.750
Ground Platform test and evaluation (24 missions)	0.0013	0.0010	0.0021	0.0002	0.0017
Years: 2009 and 2010 (per year) (169 Air/24 Ground Missions)					
Aircraft LTOs/TGOs[a] (169 flights)					
Test and Evaluation Mission Aircraft ABL (Boeing 747), AC-130, B1-B, H-47, F-22, MV-22, and UAV	6.864	2.058	1.672	0.034	8.141
Chase Aircraft (169 flights) T-38, F-15, and F-16	2.414	0.481	0.309	0.014	3.255
Target Aircraft[a] (56 flights) Proteus	0.063	0.012	0.032	0.001	0.146
Aerospace Ground Equipment	0.497	0.012	0.043	0.036	0.034
Ground Support Equipment	0.264	0.434	2.884	----	3.319
Ground Platform Test and Evaluation (24 missions)	0.0013	0.0010	0.0021	0.0002	0.0017

Table 4-3, Page 2 of 3

Table 4-3

Conformity Applicability for Total Emissions Sources

Associated with Alternatives A and B (Continued)

Emission Source	NO_2	VOC	PM_{10}	SO_2	CO
Totals					
Year 2006	3.176	0.938	1.683	0.028	4.727
Year 2007	3.514	1.396	1.917	0.032	6.045
Year 2008	7.028	2.792	3.832	0.063	12.091
Year 2009	10.103	2.997	4.988	0.085	14.897
Year 2010	10.103	2.997	4.988	0.085	14.897
De minimis thresholds KCAPCD	100	100	N/A	N/A	N/A
De minimis thresholds MDAQMD	25	25	100	N/A	N/A
De minimis thresholds AVAQMD	25	25	N/A	N/A	N/A
Kern County, MDAB portion of inventory[b]	10,950	4,380	N/A	N/A	N/A
AVAQMD inventory[c]	10,220	12,775	N/A	N/A	N/A
MDAQMD inventory[c]	41,610	16,790	34,310	N/A	N/A
Percentage of Inventory[d]					
Year 2006	0.0003	0.0002	0.00005	N/A	N/A
Year 2007	0.0003	0.0003	0.00006	N/A	N/A
Year 2008	0.0007	0.0006	0.0001	N/A	N/A
Year 2009	0.001	0.0007	0.0001	N/A	N/A
Year 2010	0.001	0.0007	0.0001	N/A	N/A

Table 4-3, Page 3 of 3

Notes: All emissions are in tons per year.

a – Does not include emissions above 3,000 feet AGL.

b – Expected inventory for 2005 based on previous data.

c – Expected inventory based on 1994 California ozone SIP and CARB 2000 estimated average annual emission.

d – Percentages of inventory are based on lowest value for KCAPCD (MDAB portion), AVAQMD, and MDAQMD.

CO – carbon monoxide

LTO – landing and takeoff

N/A – not applicable

NA – not available

NO_x – nitrogen oxides

PM_{10} – particulate matter 10 microns or less in diameter

Table 4-3

Conformity Applicability for Total Emissions Sources Associated with Alternatives A and B (Continued)

Notes: (Continued)

SO_x – sulfur oxides

TGO – touch and go

VOC – volatile organic compound

An air conformity applicability screening analysis was conducted for the proposed project. The Kern County portion (East Kern County) of Edwards AFB is now in attainment of the federal 1-hour ozone standard and is now under a federally approved SIP maintenance plan (*Federal Register* 2004). The proposed project would conform to the most recent U.S. EPA-approved SIP if the total direct and indirect emissions remained below *de minimis* thresholds established in the U.S. EPA's conformity rule for general federal actions. For KCAPCD the conformity *de minimis* levels for ozone and ozone precursors (NO_x and VOCs) are 100 tons per year per pollutant. Because the area is in attainment or unclassified for the remaining criteria pollutants, no screening analysis was necessary. Emissions analyzed for conformity applicability analysis from aircraft LTOs and flights and AGE/GSE sources are summarized in Table 4-3.

The primary area that would be affected by the emissions shown in Table 4-3 is the immediate area around Edwards AFB, situated in the MDAB portion of Kern County. The Valley portion of Kern County, situated in the SJVAPCD, and the area in the GBUAPCD that underlies the of R-2508 Complex were not included in the conformity applicability analysis screening because the Valley portion and the area under R-2508 Complex in the GBUAPCD are not anticipated to be affected by the proposed project because the test aircraft would be well above 3,000 feet AGL in these areas. Table 4-3 indicates the ozone precursor emissions (NO_2 and VOCs) would be less than the *de minimis* thresholds of 100 tons per year for a serious ozone nonattainment area for the MDAB portion of Kern County (40 CFR Part 93 Subpart 153[b][2]) for all areas. In addition, the emissions of ozone precursors would not exceed 10 percent of the total Kern County inventories (40 CFR Part 93 Subpart 153[i]), and the ozone precursors and PM_{10} would be less than 10 percent of the AVAQMD or MDAQMD inventories.

There are no local concerns for carbon monoxide within the ROI for the proposed project. Emissions from the proposed project would not result in any carbon monoxide hot spots since traffic congestion and carbon monoxide nonattainment in the ROI are not local issues.

Based on the conformity applicability criteria, the proposed project would conform to the most recent U.S. EPA-approved SIP, and no further detailed conformity applicability screening analysis is required.

4.2 AIRSPACE

4.2.1 Alternative A (Desired Capability, Proposed Action Alternative)

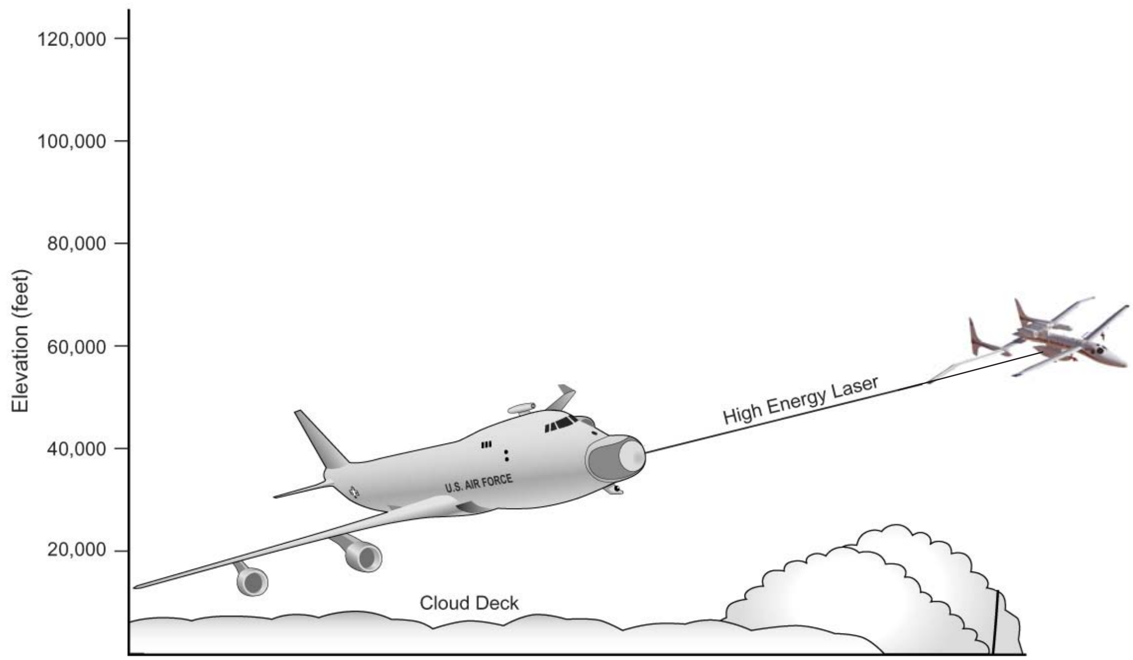
4.2.1.1 Airspace—Region 1

Region 1 is located entirely within restricted area R-2515. During flight test activities, aircraft would remain in the airspace identified as restricted area R-2515. Targets for A/A and G/A modes would be located within the airspace above Edwards AFB and A/G targets would be primarily located on the PIRA, in Management Area B (refer to the Land Use Section for a description of this area).

Flight Test Activities

Fixed wing aircraft and helicopters (similar to the Boeing 747, AC-130, F-22, H-47, MV-22, UAV and associated chase aircraft [T-38, F-15, or F-16]) involved in laser test and evaluation in A/G, G/A, and A/A modes would launch from Runway 04/22 at Edwards AFB and climb to a minimum safe altitude determined by the test plan. Airborne targets like the Proteus aircraft for A/A, A/G, and G/A testing would generally be above the targeting platform (Figure 4-1) or could be below the laser aircraft for A/A testing. Ground targets for the A/G testing would be protected by earthen berms, rock outcrops, or enclosures to control the reflected laser energy, or they would be located in controlled areas with an established and approved laser hazard zone and laser surface danger zone as described in Section 4.12, Safety and Occupational Health. The geometry of the reflected laser energy would dictate the point in the air where the lasing activities are initiated. Test plans would identify the location, beam angle, duration of the lasing event, and area on the ground where the reflected energy would be likely to occur.

Controlled and Uncontrolled Airspace. The test and evaluation of lasers would not significantly affect the existing controlled and uncontrolled, or navigable, airspace over Edwards AFB because this airspace is a dedicated asset for the use of military and test and evaluation aircraft performing their assigned missions. The airspace is restricted from the surface to an unlimited altitude. If an aircraft used for laser test and evaluation experienced an emergency situation, there could be a temporary reduction in navigable controlled and uncontrolled airspace. During any emergency involving laser test and evaluation aircraft, the lasing activities would be suspended, and failsafe measures would be implemented to preclude the inadvertent lasing of undesignated targets. In an emergency the pilot would relay requests for assistance



Example of HEL Lasing Proteus Target Board	Figure 4-1	Q242-03	1/06/05

to the TRACON for controlled and uncontrolled airspace. Emergency situations are evaluated and handled by Air Traffic Control (ATC) on a case-by-case basis, with any aircraft experiencing an emergency being afforded priority handling over all other air traffic. Therefore, impacts on controlled and uncontrolled, or navigable, airspace would not be anticipated under normal conditions.

Special Use Airspace. No new SUA is proposed and the modification of existing SUA would not be necessary to accommodate flight testing activities for laser test and evaluation in Region 1. Ongoing activities would continue to utilize the existing SUA. The laser test and evaluation aircraft would remain in restricted area R-2515 in the R-2508 Complex; however, this area would not be adversely affected since accommodating flight test aircraft would be considered a matter of routine operations in that SUA. The agency using the restricted areas coordinates with the Central Coordinating Facility (CCF), which has the autonomous authority for the R-2508 Complex shared-use airspace. The CCF acts as the single point for coordination of activities with Hi-Desert TRACON and other ATC/mission control facilities. In addition, the laser test and evaluation flight test represents precisely the kind of activities for which the restricted area SUA was created in the early 1960s: namely, to accommodate national security and necessary military activities, and to confine or segregate activities considered to be hazardous to nonparticipating aircraft.

Supersonic tests would occur in approved supersonic flight corridors like the Alpha/PIRA Supersonic Corridor and Black Mountain Supersonic Corridor or above 30,000 feet above MSL (FL 300) in accordance with AFI 13-201, *U.S. Air Force Airspace Management*.

Any additional demands that would be placed on existing SUA could be accommodated by airspace schedulers. Alternative A would not require assignment of new SUA or modification of existing SUA. Consequently, there would be no adverse impacts on special use airspace.

The scheduling office for each SUA area (CCF within restricted area R-2515) regulates the real-time activity schedule for any restricted area or MOA that could potentially be affected by an emergency. Special use airspace activities could be temporarily affected, but this would be readily accommodated by airspace schedulers.

In an emergency, the pilot would relay requests for assistance to the TRACON for SUA. Emergency situations are evaluated and handled by ATC on a case-by-case basis, with an aircraft experiencing an emergency being afforded priority handling over all other air traffic.

Military Training Routes. The test and evaluation of lasers would not adversely affect military training routes that originate at, transit through, or terminate at Edwards AFB. Scheduling the use of restricted area R-2515 and the military training routes that transit that airspace is a normal function for operating agencies at Edwards AFB. Therefore, no significant impacts would occur.

Use of restricted area R-2515 in the R-2508 Complex for the test and evaluation of lasers would not have an adverse impact on military training routes within the complex. Each military training route's "Origination Activity" or home base, which is responsible for communications and coordination with the military aircraft scheduled to use the affected routes, would be notified of the laser test and evaluation aircraft test schedule. Military training would be scheduled to ensure the appropriate separation between aircraft using the military training routes and laser test and evaluation aircraft. Therefore, short-term reductions in the availability of entire training routes or individual segments would occur; however, the rescheduling of military training route exercises is routine and would not constitute an adverse impact.

During emergency conditions, military aircraft would be rescheduled, or routed around the airspace on a case-by-case basis, so an aircraft experiencing an emergency would be afforded priority handling over all other air traffic. Thus, there would be a temporary reduction in the availability of entire training routes or individual segments.

En Route Victor Airways and Jet Routes. The test and evaluation of lasers on Edwards AFB would not adversely affect the en route airways, jet routes, or general aviation VFR traffic. There are no en route victor airways or jet routes that transect restricted area R-2515 in the R-2508 Complex (NACO 2004a, b, and c).

General aviation VFR traffic requires permission for flight within restricted area R-2515 (which extends from ground surface to an unlimited altitude); therefore, general aviation VFR traffic would not be affected by laser test and evaluation within restricted area R-2515.

Airports/Airfields. The test and evaluation of lasers would not adversely affect airports and airfields at Borax, Boron, or Edwards AFB. Edwards AFB and Edwards AF Auxiliary North Base are DoD airfields that routinely support military aircraft and flight tests. The dry lake runways at Rogers and Rosamond Dry Lakes are exclusively controlled by the TRACON. These DoD airports and airfields require that visiting aircraft obtain a prior permission request (PPR) before landing. The requirement for a PPR generally prevents aircraft that are not assigned to Edwards AFB (or NASA DFRC) from creating potential conflicts with mission aircraft. For flight tests occurring inside restricted area R-2515, the test and evaluation and chase aircraft would operate above 3,000 feet AGL around Borax and Boron airfields. This ensures that a laser-free zone (LFZ) between the airport and laser test and evaluation aircraft, as required by the FAA Order 7400.2E, is maintained during the flight profile.

In an emergency the pilot would relay requests for assistance to the TRACON. Emergency situations affecting airports and airfields would be evaluated and handled by ATC on a case-by-case basis. The aircraft experiencing an emergency would be afforded priority handling over all other traffic. Under these emergency conditions there could be a temporary reduction in access to airports and airfields while the aircraft maneuvers to an emergency landing site.

Air Traffic Control. Due to the small number of flights anticipated per year (less than 3 percent of the annual flight activity occurring at Edwards AFB), no significant impacts on ATC are anticipated.

Ground Test Activities

There would be no adverse impacts on uncontrolled airspace, SUA, military training routes, victor en route airways, jet routes, airport/airfields, or air traffic control. The G/G laser test and evaluation events would occur on Edwards AFB, and G/G mode would include aircraft and other types of platforms firing lasers at ground targets. Kilowatt-class and aboveground tests involving free space lasing could require establishing a CFA. This CFA would be activated by a NOTAM, and pertinent information would be placed on the Edwards Automated Terminal Information Service. Because the lasing activities would be suspended immediately if ground observers with binoculars scanning the sky near the target location indicated an aircraft might be approaching this area, there would be no impacts on controlled and uncontrolled airspace, SUA, military training routes, enroute airways or jet routes, other airfields and airports, or ATC in the airspace used to support the Proposed Action. There would be no need to chart the CFA since this area would not cause a nonparticipating aircraft to change its flight path. Similarly, since none of these lasing activities would restrict a clear view of the runways, helipads, taxiways, or traffic patterns from any airport control tower; decrease airport capacity or efficiency, or affect future VFR or IFR traffic, the CFA would not constitute an obstruction to air navigation (AFFTC 2004).

Rotoplanes, target boards, and other ground targets would utilize earthen berms, rock outcrops, backdrops, buffer zones, beam path restrictors, or a combination of these measures to control the reflected laser energy. Open-range ground testing of unshrouded lasers would not occur if standing water were present between the targeting platform and target area. During G/G laser test and evaluation activities, range personnel would be required to conduct visual inspections of the area to verify that personnel or aircraft had not entered the laser hazard zone (LHZ).

Communications Laser Tests

There would be no adverse impacts on airspace from implementing the Proposed Action and testing communications lasers. The primary consideration and hazard in the ROI for communication laser systems is eye safety. Laser eye safety is discussed in Section 4.13. Free space optics (FSO) communications systems use modulated optical or laser beams to send telecommunication information through the atmosphere (Killinger 2002). Communication lasers operating in the G/A, G/S, S/G, and A/G modes would use the airspace above Edwards AFB, restricted area R-2515, and R-2508 Complex. Most of the current FSO systems use 0.8-meter light-emitting diodes, a 0.8-meter diode laser, or a 1.5-meter diode laser. The gallium-arsenic-aluminum diode lasers operating at 0.8–0.9 meter wavelengths use continuous wave power levels on the order of 0.001 to 0.1 W, while indium-gallium- arsenic-phosphorus diode lasers near the 1.5 μm wavelength operate with tens of milliwatts of power. The power levels in these systems may be boosted by laser amplifiers to 1 to 10 watts and up to several hundred watts for specific satellite communication applications (Hecht 2003). Most FSO communication systems are designed to be eye safe or to operate where the human eye cannot intercept the beam. Similar to the G/A, G/G, and A/G laser test and evaluation, during communication laser test and evaluation activities range personnel would be required to conduct visual inspections of the area to verify that personnel or aircraft had not entered the LHZ. Pilots in aircraft and ground personnel involved with the specific laser tests would be fitted with appropriate eye safe laser protection (goggles) to ensure there were no impacts.

4.2.1.2 Airspace—Region 2

Flight Test Activities

During flight tests in Region 2, laser test and evaluation aircraft would remain within airspace defined as the R-2508 Complex. All airborne targets would be lased within the airspace over Edwards AFB, and the flight pattern would remain within restricted area R-2515; all ground targets used for laser test and evaluation flight testing would be located on Edwards AFB, primarily in Management Area B (refer to Section 3.8, Land Use, for a description of this area).

Controlled and Uncontrolled Airspace. Impacts on controlled and uncontrolled, or navigable, airspace would not be anticipated under normal conditions. No new SUA or modification to the existing SUA would be necessary or contemplated to accommodate the flight-test activity using HEL at Edwards AFB or within the R-2508 Complex. The test and evaluation of lasers would not significantly affect the existing controlled and uncontrolled, or navigable, airspace in Region 2 because the airspace is a dedicated asset for the use of military and test and evaluation aircraft performing their assigned missions. If an aircraft used for laser test and evaluation experienced an emergency situation there could be a temporary reduction in navigable controlled and uncontrolled airspace. In an emergency, the pilot would relay requests for assistance to TRACON for flight through controlled and uncontrolled airspace. Emergency situations are evaluated and handled by ATC on a case-by-case basis, with any aircraft experiencing an emergency being afforded priority handling over all other air traffic.

Special Use Airspace. The test and evaluation of lasers would not adversely affect the existing SUA within the R-2508 Complex.

All flight test activities would comply with FAA requirements and altitude restrictions for overflight of wilderness areas, parks, and urban areas; no effects on airspace over the national parks, wilderness areas, or urban areas would be expected. Targets for lasing in the A/A mode would not be situated over any national parks, wilderness areas, or special management areas (Figure 4-2). Ground-based targets for A/G and G/A laser testing would be located exclusively on Edwards AFB.

The test and evaluation aircraft would operate in the R-2508 Complex. Other aircraft operating in this area would not be adversely affected since accommodating aircraft testing would be considered a matter of routine operations in that SUA. The agency using the restricted areas coordinates with the CCF who has the autonomous authority for the R-2508 Complex shared-use airspace. The CCF acts as the single point for coordination of activities with High Desert TRACON and other ATC/mission control facilities. In addition, the proposed flight testing represents precisely the kind of activities for which the restricted area SUA was created in the early 1960s, namely, to accommodate national security and necessary military activities, and to confine or segregate activities considered to be hazardous to nonparticipating aircraft.

Supersonic tests would occur in approved supersonic flight corridors like the Alpha/PIRA Supersonic Corridor and Black Mountain Supersonic Corridor or above 30,000 feet above MSL (FL 300) in accordance with AFI 13-201, *U.S. Air Force Airspace Management*.

Any additional demands that would be placed on existing SUA could be accommodated by airspace schedulers. Alternative A would not require assignment of new SUA or modification of existing SUA. Consequently, there would be no adverse impacts to SUA.

The scheduling office for each SUA area (CCF within restricted area R-2515) regulates the real-time activity schedule for any Restricted Area, MOA, or Warning Area that would be affected by an emergency. Special use airspace activities could be temporarily affected, but would be readily accommodated by airspace schedulers.

In an emergency, the pilot would relay requests for assistance to the TRACON for SUA. Emergency situations are evaluated and handled by ATC on a case-by-case basis, with an aircraft experiencing an emergency being afforded priority handling over all other air traffic.

Military Training Routes. The test and evaluation of lasers would not adversely affect military training routes that originate in, transit through, or terminate in the R-2508 Complex. Scheduling the use of the R-2508 Complex and the military training routes that transit that airspace is a normal function for the scheduling office. Therefore, no significant adverse impacts would occur.

Use of restricted area R-2515 in the R-2508 Complex for the test and evaluation of lasers would not have an adverse impact on military training routes within the complex. Each military training route's "Origination Activity" or home base, which is responsible for communication and coordination with the military aircraft scheduled to use the affected routes, would be notified of the laser test and evaluation aircraft test schedule. Military training would be scheduled to ensure the appropriate separation between aircraft using the military training routes and laser test and evaluation aircraft. Thus, there would be short-term reductions in the availability of entire training routes, or individual segments; however, the rescheduling of military training route exercises is routine and would not constitute an adverse impact.

During emergency conditions, military aircraft would be rescheduled or routed around the airspace on a case-by-case basis, whereby an aircraft experiencing an emergency would be afforded priority handling over all other air traffic. Thus, there would be a temporary reduction in the availability of entire training routes or individual segments.

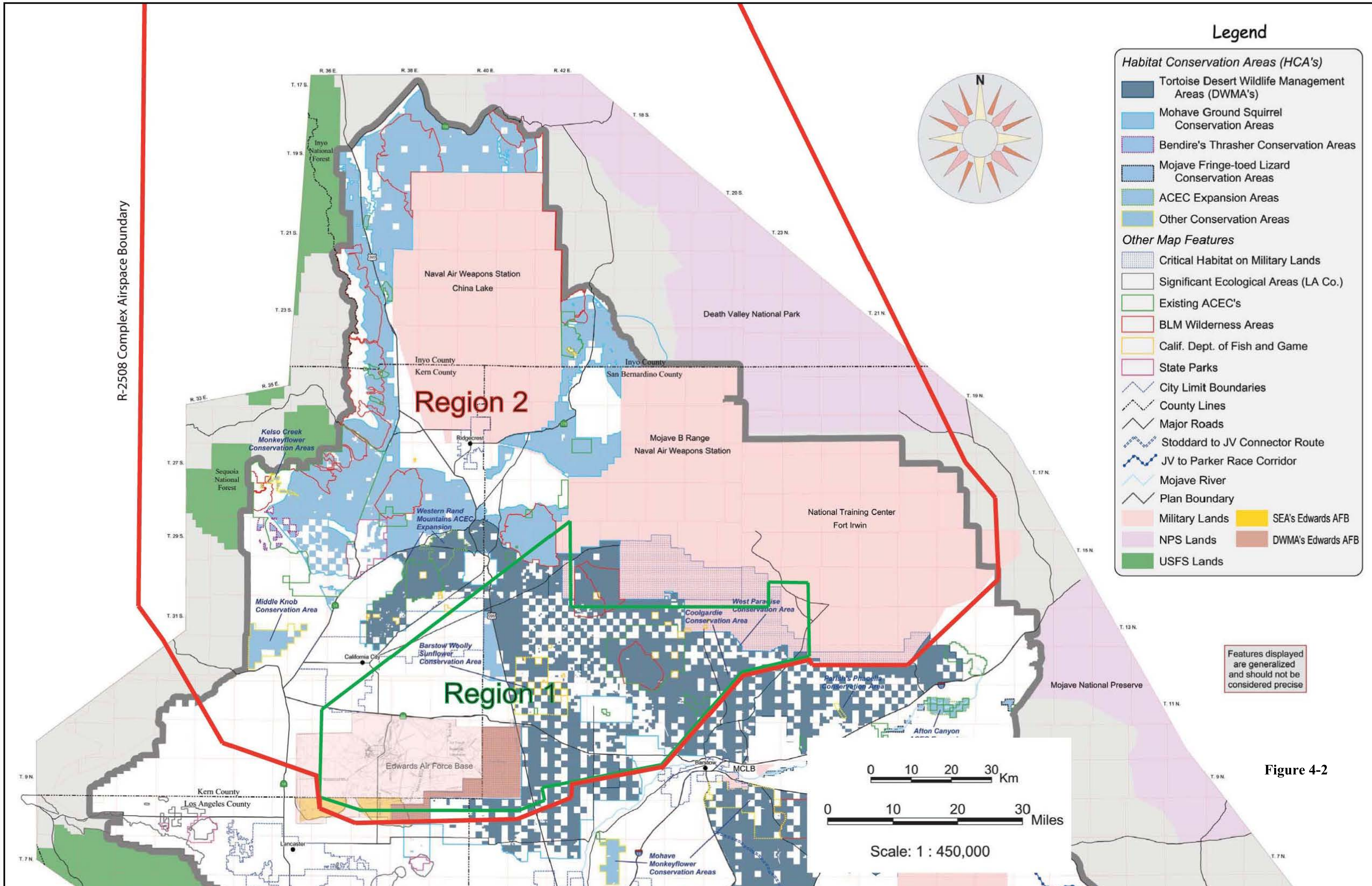

Legend
Habitat Conservation Areas (HCA's)
Tortoise Desert Wildlife Management Areas (DWMA's)
Mohave Ground Squirrel Conservation Areas
Bendire's Thrasher Conservation Areas
Mojave Fringe-toed Lizard Conservation Areas
ACEC Expansion Areas
Other Conservation Areas
Other Map Features
Critical Habitat on Military Lands
Significant Ecological Areas (LA Co.)
Existing ACEC's
BLM Wilderness Areas
Calif. Dept. of Fish and Game
State Parks
City Limit Boundaries
County Lines
Major Roads
Stoddard to JV Connector Route
JV to Parker Race Corridor
Mojave River
Plan Boundary
Military Lands
SEA's Edwards AFB
NPS Lands
DWMA's Edwards AFB
USFS Lands
N
R-2508 Complex Airspace Boundary
Region 2
Region 1
Naval Air Weapons Station
China Lake
Death Valley National Park
Inyo County
Kern County
San Bernardino County
Mojave B Range
Naval Air Weapons Station
National Training Center
Fort Irwin
Inyo National Forest
Sequoia National Forest
Kelso Creek Monkeyflower Conservation Areas
Western Rand Mountains ACEC Expansion
Ridgecrest
Middle Knob Conservation Area
Barstow Woolly Sunflower Conservation Area
California City
West Paradise Conservation Area
Coolgardie Conservation Area
Parish's Phacelia Conservation Area
Afton Canyon
Mojave National Preserve
Edwards Air Force Base
Barstow
MCLB
Kern County
Los Angeles County
Lancaster
Mohave Monkeyflower Conservation Areas
Features displayed are generalized and should not be considered precise
0 10 20 30 Km
0 10 20 30 Miles
Scale: 1 : 450,000

Figure 4-2

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En Route Victor Airways and Jet Routes. The test and evaluation of lasers would not significantly affect use of the en route airways, jet routes, or general aviation VFR traffic. No enoute victor airways and only the J110 jet route transects the R-2508 Complex. The J110 route is normally unavailable during the day from Monday through Friday (NACO 2004a).

General aviation VFR traffic below the R-2508 Complex (which extends from FL 200 to an unlimited altitude) could potentially be affected by laser test and evaluation flights. However, as noted above, the impacts would be short-lived and temporary with adequate notification provided by the TRACON and local flight service stations.

Airports/Airfields. The test and evaluation of lasers would not adversely affect airports and airfields in the R-2508 Complex. In general, most laser test and evaluation flights would originate from Edwards AFB. All test and evaluation and chase aircraft would operate above 3,000 feet AGL in the vicinity of airports and airfields during any lasing activities. This would ensure an LFZ between the airport and laser test and evaluation aircraft—as required by the FAA Order 7400.2E—is maintained during the flight profile.

In an emergency the pilot would relay requests for assistance to the TRACON. Emergency situations affecting airports and airfields would be evaluated and handled by ATC on a case-by-case basis. The aircraft experiencing an emergency would be afforded priority handling over all other traffic. Under these emergency conditions there could be a temporary reduction in access to airports and airfields while the aircraft maneuvers to an emergency landing site.

Air Traffic Control. Due to the small number of flights anticipated per year (less than 1 percent of the annual flight activity in the R-2508 Complex), no significant impacts on ATC would be anticipated.

Ground Test Activities

There would be no ground test activities in the off-base region; therefore, no mitigation would be required.

4.2.1.3 Mitigation Measures

During laser test and evaluation activities, range personnel would be required to conduct visual inspections of the area to verify that personnel or aircraft had not entered the LHZ. Laser test and evaluation mission aircraft would maintain an altitude of at least 3,000 feet AGL near any airports and airfields during lasing activities to ensure that an LFZ was maintained. Pilots in aircraft and ground personnel involved with the specific laser tests would be fitted with appropriate eye safe laser protection (goggles) to ensure there were no impacts. Test plans would establish FPs and target locations (LTAs and airborne targets) such that radiated energy would remain within the test range or be reflected upward towards infinity. Test plans would be coordinated with U.S. Space Command and other agencies as necessary to ensure that reflected energy would not impact other civilian or government assets or violate treaties with other nations.

4.2.2 Alternative B (Limited Capability)

Under Alternative B, laser test and evaluation flight tests in the A/G, G/A, G/G, and A/A modes would be limited to low power levels (like current surrogate laser sources, which project the energy from a 10–14 Watt source with an effective power of less than 1 Watt when it leaves the device) (Montoya 2005). Medium and high power testing in the A/G, G/G, and A/A modes would be limited to the inside of test facilities like the SIL and BFTF and controlled areas on Edwards AFB.

4.2.2.1 Airspace—Region 1

Flight profiles for Region 1 flight tests by laser test and evaluation aircraft would remain in restricted area R-2515. Lasing A/A and G/A targets (like the Proteus aircraft) would occur in the airspace above Edwards AFB, and A/G targets would be located primarily on the PIRA, in Management Area B (refer to Section 3.8.1.2, Land Use for a description of this area).

Flight Test Activities

Controlled and Uncontrolled Airspace. Similar to Alternative A, the test and evaluation of laser systems would not significantly affect the existing controlled and uncontrolled, or navigable, airspace over Edwards AFB. This airspace is specifically designated for testing of aircraft in support of military operations. Since laser test and evaluation flights using controlled and uncontrolled, or navigable, airspace under Alternative B would only use low power levels outside of controlled areas, and low, medium, and high power levels could be used inside test facilities like the System Integration Laboratory (SIL) and BFTF on Edwards AFB, there would be no significant impacts on controlled and uncontrolled airspace. Similar to Alternative A, the impacts on controlled and uncontrolled airspace under Alternative B would also be less than significant under normal conditions.

Special Use Airspace. Similar to Alternative A, the test events proposed under Alternative B would not significantly affect the existing SUA over Edwards AFB.

Restricted area R-2515 in the R-2508 Complex would not be adversely affected since accommodating mission aircraft would be considered a matter of routine operations for that SUA. The agency using the restricted areas coordinates with the CCF, which has autonomous authority for restricted area R-2515. The CCF acts as the single point for coordination of activities with the Hi-Desert TRACON and other ATC/mission control facilities.

Supersonic tests would occur in approved supersonic flight corridors like the Alpha/PIRA Supersonic Corridor and Black Mountain Supersonic Corridor or above 30,000 feet above MSL (FL 300) in accordance with AFI 13-201, *U.S. Air Force Airspace Management*.

Any additional demands that would be placed on existing SUA could be accommodated by airspace schedulers. Conducting laser test and evaluation flights would not require the assignment of new SUA or require the modification of existing SUA. Consequently, there would be no adverse impacts to SUA.

Military Training Routes. Similar to Alternative A, laser test and evaluation flight tests for missions proposed under Alternative B would not significantly affect the military training routes that transit restricted area R-2515 in the R-2508 Complex. Scheduling the use of restricted area R-2515 and the military training routes that transit that airspace is a normal function for TRACON. Therefore, no impacts would occur.

Use of restricted area R-2515 in the R-2508 Complex would not have an adverse impact on military training routes within the complex because rescheduling of military training route exercises is routine and would not constitute an adverse impact.

In the event of an emergency landing, each military training route's "Origination Activity" or home base, would be responsible for communication and coordination with the military aircraft using, or scheduled to use, the affected routes. There would be a temporary reduction in the availability of entire training routes or individual segments.

En Route Victor Airways and Jet Routes. The test and evaluation of lasers would not adversely affect the en route airways or jet routes because there are no en route victor airways or jet routes that transect Edwards AFB or restricted area R-2515 (NACO 2004a).

General aviation VFR traffic requires permission to enter restricted area R-2515 (which extends from the ground surface to an unlimited altitude); therefore, general aviation VFR traffic would not be affected by laser test and evaluation flights in Region 1. Consequently, there would be no adverse impacts to victor en route airways, jet routes, or general aviation VFR traffic.

Airports/Airfields. The test and evaluation of lasers would not adversely affect airports and airfields at Edwards AFB. Edwards AFB and Edwards AF Auxiliary North Base are DoD airfields that routinely support military aircraft and flight tests. The dry lake runways at Rogers and Rosamond Dry Lakes are exclusively controlled by the TRACON. The airports and airfield in Region 1 require that visiting aircraft obtain a PPR before landing. The requirement for a PPR generally prevents aircraft that are not assigned to Edwards AFB (or NASA DFRC) from creating potential conflicts with mission aircraft. For flight tests occurring inside the footprint of Edwards AFB, the test and evaluation and chase aircraft would operate above 3,000 feet AGL, which is designated as the base altitude for conducting all laser test and evaluation flights. This would ensure that an LFZ between the airport and laser test and evaluation aircraft—as required by the FAA Order 7400.2E—was maintained during the flight profile.

In an emergency, the pilot would relay requests for assistance to the TRACON. Emergency situations affecting airports and airfields would be evaluated and handled by ATC on a case-by-case basis. The aircraft experiencing an emergency would be afforded priority handling over all other traffic. Under these emergency conditions there could be a temporary reduction in access to airports and airfields while the aircraft maneuvers to an emergency landing site.

Air Traffic Control. Due to the small number of flights anticipated per year (less than 3 percent of the annual flight activity at Edwards AFB), no significant impacts on ATC would be anticipated.

Ground Test Activities

Under Alternative B, laser test and evaluation ground tests in the G/G and G/A modes would be limited to low power levels (like current surrogate laser sources which project the energy from a 10–14 watt source with an effective power of less than 1 watt when it leaves the device) (Montoya 2005). Medium and high power testing in the G/G mode would be limited to test facilities like the SIL, BFTF, and controlled areas on Edwards AFB.

The laser energy reflected off the surface of ground targets would be controlled by means of earthen berms, rock outcrops, backdrops, buffer zones, beam path restrictors, or a combination of these measures to control the reflected laser energy. Range personnel would be required to conduct visual inspections of the area to verify that personnel or aircraft had not entered the LHZ.

Communications Laser Tests

The environmental consequences of communications laser tests conducted at Edwards AFB, restricted area R-2515, and the R-2508 Complex as proposed under Alternative B would be the same as Alternative A.

4.2.2.2 Airspace—Region 2

Flight and ground tests would not occur in Region 2. Laser test and evaluation aircraft would remain within airspace defined as restricted area R-2515. All airborne targets would be located within the airspace over Edwards AFB and within restricted area R-2515; all ground targets used for laser test and evaluation flight testing would be located on Edwards AFB, primarily in Management Area B (refer to Section 3.8, Land Use, for a description of this area).

4.2.2.3 Mitigation Measures

During laser test and evaluation activities associated with implementing Alternative B, range personnel will be required to conduct visual inspections of the area to verify that personnel or aircraft have not entered the LHZ. Laser test and evaluation mission aircraft will maintain an altitude of at least 3,000 feet AGL near any airports and airfields to ensure an LFZ is maintained. Pilots in test and evaluation aircraft and ground personnel involved with the specific laser tests will be fitted with appropriate eye safe laser protection (goggles) to ensure there are no impacts. Test plans will establish FPs and target locations (LTAs and airborne targets) such that radiated energy remains within the test range or is reflected upward towards infinity. Test plans will be coordinated with U.S. Space Command and other agencies as necessary to ensure that reflected energy does not impact other civilian or government assets or violate treaties with other nations.

4.2.3 Alternative C (No-Action Alternative)

Under the No-Action Alternative, no new laser test missions other than those previously approved under the Airborne Laser Program environmental impact statements would occur. Aircraft using the R-2508 Complex would continue to comply with approved flight profiles and missions per applicable DoD, Air Force, and AFFTC instructions. There would be no additional impacts on airspace resulting from implementing the No-Action Alternative. No additional mitigation measures beyond those described in the environmental impact statements would be required if Alternative C were implemented.

4.3 CULTURAL RESOURCES

Potential impacts to cultural resources associated with airspace use generally include physical damage to buildings, structures, or rock features through accident or vibration, visible or audible impacts to the setting of cultural resources, and disturbance of traditional activities such as religious ceremonies or subsistence hunting. Impacts on cultural resources from airspace use are most likely to be related to alterations in setting from visible or audible disturbance and the extremely remote possibility of off-target lasing.

4.3.1 Alternative A (Desired Capability, Proposed Action Alternative)

4.3.1.1 Cultural Resources—Region 1

During flight and ground testing (A/A, A/G, G/A, and G/G modes) in Region 1, laser targets would be primarily located at one of the five 5-acre LTAs on the PIRA. These existing sites were selected because cultural artifacts are not known to be located near the targets. Any new LTAs, including additional sites at AFRL, would be investigated by 95 ABW/CEV to verify that cultural artifacts are not present before these areas were designated as approved target sites. Test plans involving airborne targets over Edwards AFB would be designed so that target impacts would occur at one of the designated target sites on the PIRA, AFRL, or an impact area on Edwards AFB that has been verified not to contain cultural artifacts. Project personnel would use existing roads when traveling to recover lased targets from designated target sites, thus minimizing ground disturbance and potential impacts to undiscovered cultural artifacts or sites.

Under the Proposed Action, aircraft would operate at supersonic speeds; however the flight profiles would only occur in the Black Mountain Supersonic Corridor or Alpha/PIRA Supersonic Corridor or above 30,000 feet above MSL (FL 300) in accordance with AFI 13-201, *U.S. Air Force Airspace Management*. Except for a small northwest portion of the Black Mountain Supersonic Corridor, both of these corridors are within restricted area R-2515 airspace. Potential noise impacts on cultural resources associated with flight in these corridors are addressed in the *Environmental Assessment to Extend the Supersonic Speed Waiver for Continued Operations in the Black Mountain Supersonic Corridor and Alpha Corridor/Precision Impact Range Area* (AFFTC 2001). A FONSI was completed for that EA which established that supersonic flight activity up to 740 flights annually would not create a significant noise impact on cultural resources in the area.

Testing communication laser systems would not impact cultural resources on Edwards AFB. The low to medium power levels (less than 1 kW [Hecht 2003]) that would be used for communication laser tests would not be directed at any cultural resource sites. Consequently, cultural resources impacts in Region 1 would not be anticipated.

The northern portion of Rogers Dry Lake, a National Historic Landmark, is a significant cultural resource in Region 1. The continued use of the landmark in assessing leading-edge space technology enhances its role in the history of technological advances in aviation and aerospace. This asset has been used to support flight and ground test missions for over 50 years. Range personnel would use existing roads, whenever possible, to recover and transport lased targets for analysis. Therefore, there would be no adverse effects on this landmark or other known cultural resources in Region 1.

4.3.1.2 Cultural Resources—Region 2

Cultural resources (prehistoric, historic, Native American reservations and areas of critical environmental concern) exist within Region 2 (the R-2508 Complex) (see Figure 3-12). In the G/G mode, targets located outside of Edwards AFB would not be lased under Alternative A. Therefore, impacts on cultural resources in Region 2 outside of Edwards AFB would not occur as a result of implementing the Proposed Action.

Flight and ground test activities by laser test and evaluation aircraft operating in restricted area R-2515 and the R-2508 Complex would be similar to current flight activities. Aircraft would take off from Edwards AFB, conduct flight operations in the R-2508 Complex, and return to land at Edwards AFB. While lasing activities during these flight tests would originate outside of Edwards AFB, all radiated energy would be focused on ground targets on Edwards AFB and airborne targets inside the airspace above Edwards AFB (inside restricted area R-2515).

Supersonic flight test activity would not occur in Region 2.

Testing communication laser systems would not impact cultural resources in Region 2. The low to medium power levels (less than 1 kW [Hecht 2003]) that would be used for communication laser tests would not be directed at any cultural resources. Consequently, impacts to cultural resources would not be anticipated.

4.3.1.3 Mitigation Measures

Prior to using one of the five identified LTAs or any new LTAs, Environmental Management (95 ABW/CEV) will verify that cultural artifacts are not present prior to designating them as approved LTAs. Test plans involving ground targets at Edwards AFB will be designed so that target impacts occur at one of the designated target sites on the PIRA or an impact area on Edwards AFB that has been verified not to contain cultural artifacts. Recovery of the lased target from designated target sites will be done in a way that minimizes ground disturbance and potential impacts to undiscovered cultural artifacts or sites. Range personnel will use existing roads, whenever possible, to recover and transport lased targets for analysis. To ensure there is no impact to cultural resources in Region 1 and Region 2; flight tests will be developed to ensure laser energy avoids areas of critical environmental concern as shown in Figure 3-12.

4.3.2 Alternative B (Limited Capability)

4.3.2.1 Cultural Resources—Region 1

There would be no adverse effects on known cultural resources in Region 1 or on the northern portion of Rogers Dry Lake from implementing Alternative B. Since targets outside the controlled areas would be lased at low power levels (like current surrogate laser sources, which project the energy from a 10–14 watt source with an effective power of less than 1 watt when it leaves the device) (Montoya 2005), the potential for impacting cultural resources on Edwards AFB would be significantly less than under Alternative A.

Flight and ground test activities would involve only low power laser tests outside of the BFTF or SIL. Medium and high power lasing would be conducted inside these facilities. This type of testing has been previously approved for medium and high power levels (AFCEE 2003). During A/G flight tests, laser targets would be primarily located at one of the pre-existing laser target sites. These existing sites were selected because cultural artifacts are not located nearby.

Under Alternative B, aircraft would operate at supersonic speeds; however the flight profiles would only occur in the Black Mountain Supersonic Corridor or Alpha/PIRA Supersonic Corridor or above 30,000 feet above MSL (FL 300) in accordance with AFI 13-201, *U.S. Air Force Airspace Management*. Except for a small northwest portion of the Black Mountain Supersonic Corridor, both of these corridors are within restricted area R-2515 airspace. Potential noise impacts on cultural resources associated with flight in these corridors are addressed in the *Environmental Assessment to Extend the Supersonic Speed Waiver* *for Continued Operations in the Black Mountain Supersonic Corridor and Alpha Corridor/Precision Impact Range Area* (AFFTC 2001). A FONSI was completed for that EA which established that supersonic flight activity up to 740 flights annually would not create a significant noise impact on cultural resources in the area.

The northern portion of Rogers Dry Lake, a National Historic Landmark, is a significant cultural resource in Region 1. The continued use of the landmark in assessing leading-edge space technology enhances its role in the history of technological advances in aviation and aerospace. This asset has been used to support flight and ground test missions for over 50 years.

Testing communication laser systems would not impact Region 1 cultural resources. The low to medium power levels (less than 1 kW [Hecht 2003]) that would be used for communication laser tests would not be directed at any cultural resources located on Edwards AFB. Consequently, impacts on Region 1 cultural resources would not be anticipated.

4.3.2.2 Cultural Resources—Region 2

Cultural resources (prehistoric, historic, Native American reservations and areas of critical environmental concern) exist within the R-2508 Complex (see Figure 3-12). Testing of lasers in the G/G mode in portions of Region 2 that are outside of Region 1 would not occur under Alternative B. Therefore, impacts on cultural resources in Region 2 would not occur as a result of implementing Alternative B. Flight and ground test activities by laser test and evaluation aircraft operating in restricted area R-2515 and the R-2508 Complex would be similar to current activities. Aircraft would take off from Edwards AFB, conduct flight operations in the R-2508 Complex, and return to land at Edwards AFB. While lasing activities during these flight tests would originate outside of the airspace over Edwards AFB, all low power radiated energy would be focused on ground targets on Edwards AFB and airborne targets inside the airspace above Edwards AFB (inside restricted area R-2515). To ensure there is no impact on these cultural resources, flight tests would be developed to ensure laser energy avoids these areas of critical environmental concern as shown in Figure 3-12.

Testing communication laser systems would not impact cultural resources in Region 2. The low to medium power levels (less than 1 kW [Hecht 2003]) that would be used for communication laser tests would not be directed at any cultural resources in Region 2. Consequently, impacts on cultural resources in Region 2 would not be anticipated.

4.3.2.3 Mitigation Measures

Prior to using one of the five identified LTAs or any new LTAs, Environmental Management (95 ABW/CEV) will verify that cultural artifacts are not present prior to designating them as approved LTAs. Test plans involving ground targets at Edwards AFB will be designed so that target impacts occur at one of the designated target sites on the PIRA or an impact area on Edwards AFB that has been verified not to contain cultural artifacts. Recovery of the lased target from designated target sites will be done in a way that minimizes ground disturbance and potential impacts to undiscovered cultural artifacts or sites on-Base. Range personnel will use existing roads, whenever possible, to recover and transport lased targets for analysis. To preclude impacts on Region 2 cultural resources, flight tests will be developed to ensure laser energy avoids these areas of critical environmental concern as shown in Figure 3-12.

4.3.3 Alternative C (No-Action Alternative)

Under the No-Action Alternative, no new laser test missions other than those previously approved under the Airborne Laser Program environmental impact statements would occur (AFCEE 2003; U.S. Air Force 1997). Aircraft using the R-2508 Complex would continue to comply with approved flight profiles and missions per applicable DoD, Air Force, and AFFTC instructions. There would be no additional impacts on cultural resources resulting from implementing the No-Action Alternative. No additional mitigation measures beyond those described in the Airborne Laser environmental impact statements would be required if Alternative C were implemented.

4.4 ENVIRONMENTAL JUSTICE

The Environmental Justice Interagency Working Group, mandated by EO 12898, developed guidance for determining whether an impact to human health or the environment would result in disproportionately high and adverse impacts to minority and/or low income populations. The Working Group recommends considering the following six factors to the extent practicable.

1. Whether there is or will be an impact on the natural or physical environment that significantly and adversely affects a minority or low-income population. Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities or low-income communities when those impacts are interrelated to impacts on the natural or physical environment.

2. Whether environmental effects are significant and are or may be having an adverse impact on minority populations that appreciably exceeds or is likely to appreciably exceed that on the general population or other appropriate comparison group.

3. Whether the environmental effects occur or would occur in a minority and/or low-income population affected by cumulative or multiple adverse exposures from environmental hazards.

4. Whether the health effects, which may be measured in risks and rates, are significant, or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death.

5. Whether the risk or rate of hazard exposure by a minority population or low-income population to an environmental hazard is significant and appreciably exceeds or is likely to appreciably exceed that of the general population or other appropriate comparison group.

6. Whether health effects occur in a minority population or low-income population affected by cumulative or multiple adverse exposures from environmental hazards.

Test and evaluation of DE systems using laser technology would not be conducted in areas where minority and/or low income populations live or work (all targets would be located on Edwards AFB or in restricted area R-2515 over Edwards AFB). An evaluation of each test scenario would be completed prior to approving the use of established LTAs (see Sections 4.8 and 4.12). No new development would be required, and current Air Force and contractor personnel at Edwards AFB would be used for the program. The analysis of this EA supports the conclusion that conducting laser test and evaluation would have no significant or disproportionately high or adverse environmental health or safety impacts on minority and/or low income populations.

Directed energy systems using laser technology would not be tested close to schools or residential areas. Test plans would be designed and followed to ensure the potential for these laser tests to generate disproportionately high environmental health and safety risks (including noise) to children, which must be addressed as required by EO 13045, would be less than significant; therefore, no mitigation would be required.

4.5 GEOLOGY AND SOILS

A project may result in a significant geologic impact if it increases the likelihood of, or results in exposure to earthquake damage, slope failure, foundation instability, land subsidence, or other severe geologic hazards. It may also be considered a significant geologic impact if it results in the loss of the use of soil for habitat, loss of aesthetic value from a unique landform, or loss of mineral resources; substantially affects the contaminant distribution and fate and transport in soils; or causes severe erosion or sedimentation. Normal military test and evaluation activities conducted at Edwards AFB (within the Management Areas as shown in Figure 2-3) do not contribute to exposure to earthquakes or other severe geologic hazards.

No significant adverse impacts on soils or geology would occur from the proposed laser testing. The proposed project involves potentially ground-disturbing activities (e.g., trenching, grading, off-road vehicle traffic) for Alternatives A and B for the construction of or establishment of targets. Ground targets (like target boards currently in use) would typically be made of aluminum, titanium, wood, plastic, or steel. These target boards would have attached sensors and/or data collection array to support the test and evaluation process. Soils could be directly impacted if the laser were to miss the target; however, with backdrops of natural topographic relief it is more likely that a misfired laser would encounter a geologic feature such as a rock outcrop. At low laser power, it is possible that spalling or chipping could occur and at higher laser powers, the rock could melt or fuse; however, the area fused would be less than 18 inches in diameter (maximum size of the laser beam) and located in an area specifically selected for targeting. At very high power levels, rock could vaporize (American Association of Petroleum Geologists 2005).

Test and evaluation programs would use existing facilities and modify buildings on an as-needed basis. Additional construction may be required to modify existing facilities and target sites to support the proposed programs. Major modifications to existing buildings may require a separate environmental analysis; however, no major modification or construction is anticipated.

The primary impact of laser testing on soils and geology would be associated with increased heat. The pulsing of the laser beam to target boards would be over a short duration (generally less than 10 seconds) (Leonard 1998). For tests that lase the target longer than 10 seconds, once burn-through has occurred the laser would be turned off to reduce any off-target impacts. The diameter of the laser beam at the target would be less than 18 inches. Proposed LTAs and other targets would be approved by 95 ABW/CEV

Environmental Management. Air quality impacts relative to soils would be insignificant. Based on the conformity applicability screening analysis, air emissions created during flight and ground test activities would be less than significant (Section 4.1). The lased target would not be expected to create significant air emissions. No adverse impacts would be expected from hazardous materials/waste (Section 4.6). Takeoffs and landings would be conducted from established areas on the base such as Runway 22 or the Rogers Dry Lakebed. Aircraft activities would not be expected to affect the geology and soils of the lakebed since takeoffs and landings from the lakebed are a normal occurrence.

The use of Edwards AFB for laser testing would not increase the likelihood of, or result in exposure to earthquake damage, slope failure, foundation instability, land subsidence, or other severe geologic hazards. The proposed testing would not result in the loss of soil used for habitat, loss of aesthetic value from a unique landform, loss of mineral resources, or severe erosion or sedimentation. Potential soil contamination would be reduced to a level that is less than significant through current range maintenance practices. Additionally, fragments and debris would be removed from the LTAs on a routine basis.

4.5.1 Alternative A (Desired Capability, Proposed Action Alternative)

For low, medium, and high power A/A and G/A lasing, targets would be located in the airspace over Edwards AFB and within restricted area R-2515. Airborne targets like the Proteus aircraft would generally be above the targeting platform (Figure 4-1) or could be below the laser aircraft for A/A testing. In the G/A lasing mode, the ground-based laser would be located on Edwards AFB and would be fired at targets above Edwards AFB. In the G/A mode the geometry of the testing would preclude laser energy from reaching the earth's surface. In the A/G mode, the ground target would be located only on Edwards AFB. The aircraft firing the laser toward the ground target could be at various locations within the R-2508 Complex.

4.5.1.1 Geology and Soils—Region 1

Flight Test Activities

For A/A lasing, targets would be located in the airspace over Edwards AFB and within restricted area R-2515. If one of the lased targets were to crash on base, the geology and soils could be affected. However, under normal scenarios, there is no mission that would be planned to crash the target on the Base; airborne targets are limited resources used for data collection. There would be no significant impacts on on-base geological resources and soils from conducting A/A laser testing.

Target boards and other approved ground targets used for A/G mode would be located on Edwards AFB. For A/G testing operations, areas of topographic relief would be utilized as backdrops for laser target boards during lasing events; target sites located near dry lakebeds would use earthen berms for backdrops. The purpose of the backdrop is to prevent laser beams from leaving the range when targets are lased. Aircraft would fire the laser toward A/G targets from various locations within the R-2508 Complex. The pulsing of laser beams to target boards would be of short duration (generally less than 10 seconds) (Leonard 1998). For tests that lase the target longer than 10 seconds, once burn-through has occurred the laser would be turned off to reduce any off-target impacts.

The primary effect on soils from the lasers would be from heat. Soils could be directly impacted if the laser were to miss the target; however, with backdrops of natural topographic relief it is more likely that a misfired laser would encounter a geologic feature such as a rock outcrop. At low laser power, it is possible that spalling or chipping could occur, and at higher laser powers the rock could melt or fuse. At very high levels, rock could vaporize (American Association of Petroleum Geologists 2005). Setting target boards above the soil surface is preferred in order to minimize the potential for secondary soil reflection. Reflective properties are based on factors such as mineral and moisture content, and the angle of incidence of the laser beam. Setting the target boards above the soil surface would help minimize heat impacts to the soil surface should the laser beam be slightly off-target. (Safety measures discussed in Section 4.12 would establish controls to ensure the laser beam would not radiate energy outside the established LHZ.) Other than potential impacts to soils from disturbance caused by positioning of the target or target construction, there would be no anticipated impacts on geologic resources or soils from A/G lasing.

Under the Proposed Action, aircraft would operate at supersonic speeds; however the flight profiles would only occur in the Black Mountain Supersonic Corridor or Alpha/PIRA Supersonic Corridor or above 30,000 feet above MSL (FL 300) in accordance with AFI 13-201, *U.S. Air Force Airspace Management*. Except for a small northwest portion of the Black Mountain Supersonic Corridor, both of these corridors are within restricted area R-2515 airspace. Potential noise impacts on the geology and soils associated with flight in these corridors are addressed in the *Environmental Assessment to Extend the Supersonic Speed Waiver for Continued Operations in the Black Mountain Supersonic Corridor and Alpha Corridor/Precision Impact Range Area* (AFFTC 2001). A FONSI was completed for that EA which established that supersonic flight activity up to 740 flights annually would not create a significant impact on the geology and soils in the area.

During G/A testing, lasing toward the air-based target would occur from an established FP on Edwards AFB to the target within varying locations of the R-2508 Complex. Other than potential impacts to soils from disturbance caused by positioning of the target or target construction, there would be no anticipated impacts on geologic resources or soils from G/A lasing.

Ground Test Activities

During G/G testing, lasers would be directed over open land to ground targets with backdrops on Edwards AFB. No G/G testing would be conducted under the R-2508 Complex except in Region 1 (Edwards AFB). The pulsing of laser beams to target boards would be over a short-term (generally less than 10 seconds) (Leonard 1998). For tests that lase the target longer than 10 seconds, once burn-through has occurred the laser would be turned off to reduce any off-target impacts. The diameter of the laser beam would be less than 18 inches at the target (the diameter of the beam at the target is generally no larger than the beam size when the beam leaves the laser).

Soils on Edwards AFB could be directly impacted if the laser were to miss the LTA; however, with backdrops of natural topographic relief it is more likely that a misfired laser would encounter a geologic feature such as a rock outcrop. At low laser power, it is possible that spalling or chipping could occur, and at higher laser powers the rock could melt or fuse. At very high levels, rock could vaporize (American Association of Petroleum Geologists 2005). Setting target boards above the soil surface is preferred in order to minimize the potential for secondary soil reflection. Reflective properties are based on factors such as mineral and moisture content and the angle of incidence of the laser beam.

Communications Laser Tests

The testing of communications laser systems would not create significant impacts to geological resources or soils. These tests would be similar to the flight and ground tests noted above; however, due to the reduced power levels (0.01 to 200 watts per cubic centimeter [W/cm^3]) used by free space optical systems, the potential for any impact would be less. There would be no impacts on geologic resources and soils during A/S and S/A testing modes since the laser energy during these modes of operation would not reach the earth's surface.

4.5.1.2 Geology and Soils—Region 2

All ground targets and FPs for the proposed A/G and G/A testing modes under Alternative A laser test and evaluation activities would be located in Region 1; no impacts to Region 2 geological resources and soils would occur. Supersonic flights associated with the Proposed Action would not occur in Region 2 and therefore would not impact the geology or soils in the area. No G/G laser testing would be conducted on the land area in Region 2 except that portion defined as Region 1.

4.5.1.3 Mitigation Measures

All earthwork will be planned and conducted to minimize the time soils are left unprotected. The extent of the area of disturbance necessary to accomplish the project will be minimized. Ground-disturbance activities will be delayed during high wind conditions (in excess of 25 knots [29 miles per hour]). Vehicular traffic, grading, and digging will not be permitted in the project area during high wind conditions. Use of off-road vehicles will be kept to a minimum. Whenever possible, the Air Force will use existing roads to establish LTAs.

A digging permit (AF Form 103) will be required if digging 4 inches or more below the surface is required. Any fill material required for constructing targets will be obtained from an approved on- or off-base location.

Construction activities have the potential to uncover unknown contaminated soil. If contaminated soil is discovered, the proponent will notify 95 ABW/CEV, Environmental Management, Restoration Branch, immediately. Contaminated soil must be removed in accordance with applicable federal, state, and local regulations.

The target area will be cleared of any debris and before any additional laser testing is conducted in a particular target area. Therefore, no significant impacts on soil contamination and fate and transport are anticipated.

4.5.2 Alternative B (Limited Capability)

4.5.2.1 Geology and Soils—Region 1

Flight Test Activities

For A/A low power lasing, targets would be located in the airspace over Edwards AFB and within restricted area R-2515. Aircraft firing toward the A/A target could be at other locations within the R-2508 Complex. There would be no impacts on Region 1 or Region 2 geologic resources or soils from conducting low power A/A testing, because there would be insufficient power to create an impact.

For A/G testing operations, areas of topographic relief or earthen berms would be utilized as backdrops for laser target boards during lasing events. Target boards and other approved ground targets used for A/G mode would be located on Edwards AFB. The purpose of the backdrop is to prevent errant laser beams from leaving the range during lasing of targets. Aircraft would fire the laser toward A/G targets from various locations within the R-2508 Complex. The pulsing of laser beams to target boards would be of short duration (generally less than 10 seconds) (Leonard 1998). For tests that lase the target longer than 10 seconds, there would be insufficient power to burn through the target surface; thus no impacts on the soil would occur. The diameter of the laser beam would be less than 18 inches at the target (the diameter of the beam at the target is generally no larger than the beam size when the beam leaves the laser).

Soils would not be directly or indirectly impacted if the laser were to miss the target because the power settings are extremely low (like current surrogate laser sources which project the energy from a 10–14 watt source with an effective power of less than 1 watt when it leaves the device [the common household light bulb is 60 watts]) (Montoya 2005). With backdrops of natural topographic relief behind most LTAs it is more likely that a misfired laser would encounter a geologic feature such as a rock outcrop. Setting target boards above the soil surface is preferred in order to minimize the potential for secondary soil reflection and reflection off spectral surfaces. Reflective properties are based on factors such as mineral and moisture content, and the angle of incidence of the laser beam. Setting the target boards above the soil surface would help minimize heat impacts to the soil surface should the laser beam be slightly off target (safety measures discussed in Section 4.12 would establish controls to ensure the laser beam would not radiate energy outside the established LHZ).

During G/A testing, low power lasing toward the air-based targets would occur from an established FP on Edwards AFB to the target within varying locations of restricted area R-2515. Other than potential impacts on soils from soil disturbance from positioning of the target or target construction, there would be no anticipated impacts on soils from G/A lasing.

Under Alternative B, aircraft would operate at supersonic speeds; however the flight profiles would only occur in the Black Mountain Supersonic Corridor or Alpha/PIRA Supersonic Corridor or be flown above 30,000 feet above MSL (FL 300) in accordance with AFI 13-201, *U.S. Air Force Airspace Management*. Except for a small northwest portion of the Black Mountain Supersonic Corridor, both of these corridors are within R-2515 restricted airspace. Potential noise impacts on geology and soils associated with flight in these corridors are addressed in the *Environmental Assessment to Extend the Supersonic Speed Waiver for Continued Operations in the Black Mountain Supersonic Corridor and Alpha Corridor/Precision*

Impact Range Area (AFFTC 2001). A FONSI was completed for that EA which established that supersonic flight activity up to 740 flights annually would not create a significant impact on geology and soils in the area.

Ground Test Activities

During ground testing, low power lasing would be directed over open land to ground targets with backdrops on Edwards AFB. No G/G exercises would be conducted on the surface of the area under the R-2508 Complex except Region 1 as noted above.

Soils would not be directly or indirectly impacted if the laser were to miss the target because the power settings would be extremely low (like current surrogate laser sources which project the energy from a 10–14 watt source with an effective power of less than 1 watt when it leaves the device [the common household light bulb is 60 watts]) (Montoya 2005). With backdrops of natural topographic relief behind most LTAs, it is more likely that a misfired laser would encounter a geologic feature such as a rock outcrop. Setting target boards above the soil surface is preferred in order to minimize the potential for secondary soil reflection and reflection off spectral surfaces. Reflective properties are based on factors such as mineral and moisture content, and the angle of incidence of the laser beam. Setting the target boards above the soil surface would help minimize heat impacts to the soil surface should the laser beam be slightly off target. (Safety measures discussed in Section 4.12 would establish controls to ensure the laser beam would not radiate energy outside the established LHZ.)

Communications Laser Tests

There would be no anticipated impacts on geologic resources and soils during A/S and S/A testing modes since the laser energy during these modes is lased at an extremely low power settings. In the S/A mode of operation the laser energy would not reach the earth’s surface.

4.5.2.2 Geology and Soils—Region 2

All ground targets and FPs for the proposed A/G and G/A testing modes under Alternative B would be located in Region 1; therefore, no impacts to Region 2 geological resources and soils would occur. Supersonic flights associated with Alternative B would not occur in Region 2; therefore, supersonic flight activities would not impact the geology or soils in the area. No G/G laser testing would be conducted in Region 2.

4.5.2.3 Mitigation Measures

Mitigation measures for Alternative B are the same as described for Alternative A.

4.5.3 Alternative C (No-Action Alternative)

Under the No-Action Alternative, no new laser test missions other than those previously approved under the Airborne Laser Program environmental impact statements would occur (AFCEE 2003; U.S. Air Force 1997). Aircraft using the R-2508 Complex would continue to comply with approved flight profiles and missions per applicable DoD, Air Force, and AFFTC instructions. There would be no additional impacts on geology and soils resulting from implementing the No-Action Alternative. No additional mitigation measures beyond those described in the Airborne Laser environmental impact statements would be required if Alternative C were implemented.

4.6 HAZARDOUS MATERIALS /HAZARDOUS WASTE

A project may result in a significant hazardous materials/hazardous waste impact if it increases the potential for exposure to hazardous materials/hazardous waste or increases the likelihood of a hazardous waste release to the environment. Impacts to hazardous materials and waste management would also be considered significant if they resulted in noncompliance with applicable regulatory guidelines or increased the amounts generated beyond available waste management capacities.

Solid waste impacts would be considered significant if they resulted in noncompliance with applicable regulatory guidelines or increased the amounts generated beyond available waste management capacities. Environmental compliance audits and inspections are conducted annually by base personnel or by an outside Air Force agency to verify that established environmental guidelines are followed (U.S. Air Force 1995).

4.6.1 Alternative A (Desired Capability, Proposed Action Alternative)

4.6.1.1 Hazardous Materials/Hazardous Waste—Region 1 and Region 2

Flight Test Activities

Hazardous materials associated with aircraft involved in flight tests would include jet fuel and other petroleum, oils, and lubricants (POLs) required to support the test and evaluation of various airborne lasers at Edwards AFB. Management of POLs is governed by Air Force Instructions. When the laser test and evaluation aircraft are on the runway or flightline, hazardous materials and hazardous waste are managed under the requirements of the AFFTC *Hazardous Waste Management Plan*. If a spill occurred, the hazardous waste would be cleaned up in accordance with AFFTC SPR Plan 32-4002, *AFFTC Oil and Hazardous Substance Spill Prevention and Response Plan*.

The chemicals and gases currently required for test and evaluation of the COIL at Edwards AFB are identified in Table 3-10. Plans developed by the System Program Office for the laser test and evaluation aircraft have established procedures and protocols for management of onboard hazardous materials and waste. Sections 301–304 of the *Emergency Planning and Community Right-to-Know Act* (EPCRA) require the community to be informed of the storage and use of certain chemical and chemical compounds. Edwards AFB complies with these EPCRA requirements. Copies of material safety data sheets for all chemicals must be maintained. A Tier II report (EPCRA Section 312) is required for chlorine, ammonia, JP-8, and the 60 and 70 percent hydrogen peroxide. Depending on the quantity of a chemical used, an annual summary of toxic chemicals (submitted on a Form R) may also be required. Table 4-4 identifies federal and California threshold reporting requirements for typical COIL and other ABL/ATL chemicals.

Chemicals associated with solid state lasers are primarily used for cooling the laser, laser gain medium, and batteries. Ethylene glycol (antifreeze) used to cool the solid state laser would be contained in a closed loop system and recycled according to established pollution prevention procedures. Lithium, chromium, neodymium, erbium, or titanium ions (there may be others as this technology matures) are added to the laser gain medium (YAG, YLF, sapphire, and silica glass) to enhance its ability to produce laser energy. These chemicals become integral to the laser gain medium and would be managed according to the AFFTC *Hazardous Waste Management Plan.* Sealed lithium ion batteries are used to store electrical power. When these batteries become waste they will be handled according to the AFFTC *Hazardous Waste Management Plan*.

Effluents from HEL operations are processed through scrubbers and through chemical reactions that produce non-hazardous by-products (AFFTC 2003). Airborne releases of any chemicals associated with Region 1 or 2 laser test and evaluation are described in Section 4.1, Air Quality.

Table 4-4

COIL and Other ABL/ATL Chemical Reporting Requirements (in pounds)

			RMP	EPCRA			
Chemical	**Quantity Stored**	**Cal ARP**	**§112r**	**§302**	**§304**	**§312**	**§311/313**
Chlorine	Up to 5,000	100	2,500	100	10	100	Yes
Anhydrous ammonia	Up to 99,000	500	10,000	500	100	500	Yes
70 % Hydrogen peroxide	Up to 50,000	N/A	N/A	1,000 > 52 %	1,000 > 52 %	10,000	No
Potassium hydroxide	Up to 30,000	N/A	N/A	N/A	N/A	10,000	No
Sodium hydroxide	Up to 30,000	N/A	N/A	N/A	N/A	10,000	No
Lithium hydroxide	Up to 44,000	N/A	N/A	N/A	N/A	10,000	No
Iodine	Up to 500	N/A	N/A	N/A	N/A	10,000	No
Nitrogen gas	Up to 1,3000	N/A	N/A	N/A	N/A	10,000	No
37 % Hydrogen chloride	Up to 5,000	N/A	5,000	500	5,000	15,000	N/A
Liquid nitrogen	4,000	N/A	N/A	N/A	N/A	10,000	No
Helium	Up to 5,000	N/A	N/A	N/A	N/A	10,000	No

Notes: Cal ARP – California Accidental Release Prevention Program

EPCRA – Emergency Planning and Community Right to Know Act

RMP – Risk Management Plan (federal)

The Air Force's Class A flight mishap rating for 2003 was 1.39 mishaps per 100,000 flight hours (Air Force Association Magazine 2004). The probability of a crash of the laser test and evaluation aircraft is extremely remote. Since the probability of a crash is remote, on-base hazardous waste impacts within IRP sites would not be anticipated. If a crash or catastrophic release associated with laser testing occurred in Region 1 or Region 2, the Air Force would be responsible for assessing and cleaning up the crash site to pre-crash conditions. This would include cleaning up hazardous wastes and disposing of the solid waste debris; thus, there would be a less than significant hazardous or solid waste impact. The Air Force, Army, and Navy, as members of the R-2508 Complex Control Board, have a letter of agreement with BLM, Inyo National Forest, Sequoia National Forest, Sequoia and Kings Canyon National Parks, and Death Valley National Park that stipulates DoD responsibilities in the unlikely event that an accident involving DoD resources occurs on federal lands managed by these agencies. Because the probability of a crash would be extremely low, impacts on hazardous or solid waste would not be anticipated.

Ground Test Activities

The hazardous materials currently required for test and evaluation of the COIL at Edwards AFB are identified in Table 3-10. Testing of other types of lasers would introduce additional hazardous chemicals. Table 4-5 shows other potential types of lasers and their associated hazardous chemical components that could be tested at Edwards AFB.

Table 4-5

Lasers Potentially Tested At Edwards AFB

Hazardous Material	Laser Type
Carbon dioxide (CO_2)	Chemical
Deuterium fluoride (DF)	Chemical
Hydrogen fluoride (HF)	Chemical
Sapphire	Solid state
Silica glass	Solid state
Neodymium (Nd):YAG	Solid state
Yttrium aluminum garnet (YAG)	Solid state
Yttrium lithium fluoride (YLF)	Solid state

Source: Directed Energy Professional Society 2004

Hazardous materials associated with chemical and solid state lasers similar to those identified in Table 4-5 would be managed according to established procedures at Edwards AFB. Other hazardous materials such as JP-8 and other POLs would be required to support the test and evaluation of various kinds of lasers used for ground test at Edwards AFB. Management of the POLs is governed by Air Force instructions. When the laser test and evaluation aircraft are on the flightline, hazardous materials and hazardous waste are managed under the requirements of AFFTC Plan 32-7042, *Hazardous Waste Management Plan*. The 95ABW/CEV (Environmental Management staff) has oversight responsibilities and will be consulted to ensure that the proper characterization, storage, handling, and disposal of all waste products (HM, HW, and solid waste) associated with laser test programs conducted from Edwards AFB occurs.

If a spill occurred, the hazardous waste would be cleaned up in accordance with the AFFTC SPR Plan 32-4002, *AFFTC Oil and Hazardous Substance Spill Prevention and Response Plan*.

Under normal conditions there would be no adverse, significant impacts on hazardous waste or hazardous materials resulting from laser test and evaluation events. The primary hazardous contaminants likely to be released from the use of a laser system would be similar to those released by the COIL on the ABL. Thus, it is unlikely that significant quantities of the hazardous materials or waste compounds would be released to the environment from these laser test and evaluation events.

Flight–test related solid waste would include aircraft parts made of metal, plastic, rubber, composites, and other alloys. These solid wastes would be managed according to current solid waste management directives and instructions. Additional materials such as shrapnel and other debris (solid waste) resulting from lasing targets would be routinely removed from the target area as part of regularly scheduled cleanup activities (AFFTC 2001). These pieces of debris would be recycled through the DRMO or sent to the landfill for disposal and would not be considered a significant impact to solid waste management activities.

Communications Laser Tests

Hazardous materials found in communications lasers similar to FSO include GaAsAl, InGaAsP, and carbon dioxide. The GaAsAl and InGaAsP lasers are solid-state lasers that typically do not release hazardous waste. Like other solid state lasers, their power is derived from an electrical source, which would be produced by a military or commercial generator or via commercial power source. The hazardous materials and waste for the communications test would be managed according to established procedures and protocols. No significant hazardous materials/hazardous waste or solid waste impacts would be anticipated as a result of laser communications testing in Region 1 or Region 2.

4.6.1.2 Mitigation Measures

Since no significant hazardous materials/hazardous waste or solid waste impacts are anticipated under Alternative A, no mitigation will be required. Flight and ground test activities associated with laser test and evaluation in Region 1 and Region 2 would comply with existing hazardous material/waste and solid waste guidelines.

4.6.2 Alternative B (Limited Capability)

Hazardous waste/materials and solid waste impacts for flight and ground related laser test and evaluation activities resulting from implementation of Alternative B would be similar to those described under Alternative A. Since the number of missions and activities would be the same as in Alternative A, and the potential impacts identified under Alternative A would be less than significant, impacts under Alternative B would be less than significant; therefore, no mitigation would be required.

4.6.3 Alternative C (No-Action Alternative)

Under the No-Action Alternative, no new laser test missions other than those previously approved under the Airborne Laser Program environmental impact statements would occur (AFCEE 2003; U.S. Air Force 1997). Aircraft using the R-2508 Complex would continue to comply with approved flight profiles and missions under applicable DoD, Air Force, and AFFTC instructions. There would be no additional impacts on hazardous materials/waste and solid waste resulting from implementing the No-Action Alternative. No additional mitigation measures beyond those described in the Airborne Laser environmental impact statements would be required if Alternative C were implemented.

4.7 INFRASTRUCTURE

A project may have significant effects on a public utility if it increases demand in excess of utility system capacity to the point that substantial expansion becomes necessary. Significant environmental impacts could also result from system deterioration due to improper maintenance or extension of service beyond its useful life. Destruction or damage of infrastructure would also be considered a significant impact.

Additional personnel may be required to provide support for laser test and evaluation activities on a temporary basis. As such there would not be any demand on the infrastructure that could not be met by the capacities of the current systems. No additional expansion would be required to support the Proposed Action or Alternative B. No additional expansion would be required to maintain the status quo of testing activities described under Alternative C.

There would be no impacts on the utility systems (energy resources, water supply, wastewater treatment, storm water treatment, electrical distribution, natural gas, communication, or transportation) from implementation of Alternative A or B; therefore, no mitigation would be required.

4.8 LAND USE AND VISUAL/AESTHETIC RESOURCES

An impact to land use would be considered significant if the project resulted in nonconformance with approved land use plans; a decrease in visual or aesthetic resources; or a conflict with environmental plans or goals, permit requirements, or existing uses of the project area or other properties.

4.8.1 Alternative A (Desired Capability, Proposed Action Alternative)

Implementation of Alternative A would have no significant impacts on land use, and no mitigation would be required. The proposed testing would not conflict with approved land use plans, environmental plans or goals, or other testing programs conducted at Edwards AFB. Proposed LTAs and FPs would be evaluated and permitted by the Range Safety Office, Range Control Office, and 95 ABW/CEV Environmental Management prior to the lasing event. Additionally, an LSDZ would be calculated for each target and the MPE determined for safety of personnel. Use of controlled areas and existing targets on the PIRA or AFRL would not create significant adverse land use impacts.

Aircraft-mounted developmental laser systems that lase targets on any of the Edwards AFB Management Areas would be permitted for testing as authorized by 95 ABW/CEV Environmental Management, Bioenvironmental Engineering, the Range Control Office, and the Range Safety Office.

An LSDZ for each of the laser systems would be calculated and approved by the Range Control Office prior to all lasing. The LSDZ—along with the buffer angle for each system—is critical in allowing laser systems to be tested on any of the pre-designated A/G targets on Edwards AFB due to land use constraints based on biological resources.

Several of the proposed LTAs would utilize existing topographic features—such as rock outcrops—as targets, thereby minimizing the construction or use of man-made targets and man-made backdrops. The LTAs would be maintained in accordance with AFI 13-212, *Range Operations and Planning*. Test and evaluation programs would use existing facilities and modify buildings on an as-needed basis. Significant building modifications would be subject to a separate environmental review. Mission aircraft would continue to comply with approved flight profiles and procedures applicable to DoD, Air Force, and AFFTC instructions.

4.8.2 Alternative B (Limited Capability)

Impacts on land use and visual and aesthetic resources under Alternative B would be similar to those under Alternative A. Disturbance near the LTAs would be less frequent since medium and high power laser testing, and medium and high power communication laser testing would be conducted inside test facilities and controlled areas of Edwards AFB. Under Alternative B, there would be no adverse, significant impacts on land use or visual and aesthetic resources from the proposed laser testing.

4.8.3 Mitigation Measures

Implementation of Alternatives A or B would have no significant impacts on land use, and no mitigation would be required.

4.8.4 Alternative C (No-Action Alternative)

Under the No-Action Alternative, no new laser test missions other than those previously approved under the Airborne Laser Program would occur (AFCEE 2003; U.S. Air Force 1997). Aircraft using the R-2508 Complex would continue to comply with approved flight profiles and missions per applicable DoD, Air Force, and AFFTC instructions. As these activities are currently the status quo, no additional land use or visual and aesthetic resource impacts would be anticipated from their continuation. Therefore, no additional mitigations resulting from implementing the No-Action Alternative would be required.

4.9 NATURAL RESOURCES

Natural resources potentially affected by the Proposed Action would include plants, plant communities, azonal habitats, sensitive plant species, wildlife, sensitive wildlife species, sensitive habitats, designated critical habitat, desert tortoise management zones, and significant ecological areas. The types of potential effects would include ground disturbing activities, noise, chemical exposure, visual exposure to aircraft and test equipment, and aircraft and test equipment contact with wildlife and migratory birds. The analysis in this section establishes that there would be no significant adverse impacts on these natural resources from implementing the Proposed Action.

4.9.1 Alternative A (Desired Capability, Proposed Action Alternative)

4.9.1.1 Flight and Ground Test Activities—Region 1

For A/A lasing, targets would only be located in the airspace over Edwards AFB and within restricted area R-2515. Aircraft firing towards the A/A target could be at other locations within the R-2508 Complex. For flight test activities involving A/G and G/A laser test and evaluation activities, potential impacts and procedures to minimize disturbances on natural resources in Region 1 would be similar to the potential impacts and procedures associated with ground test activities. Air-to-ground lasing would be directed at approved LTAs on the PIRA (Management Area B) or AFRL (Management Area G) (Figure 4-3) or at new LTAs evaluated and approved for use by 95 ABW/CEV Environmental Management.

Under the Proposed Action, aircraft would operate at supersonic speeds; however the flight profiles would only occur in the Black Mountain Supersonic Corridor or Alpha/PIRA Supersonic Corridor or above 30,000 feet above MSL (FL 300) in accordance with AFI 13-201, *U.S. Air Force Airspace Management*. Except for a small northwest portion of the Black Mountain Supersonic Corridor, both of these corridors are within R-2515 restricted airspace. Potential noise impacts on natural resources associated with flight tests in these corridors are addressed in the *Environmental Assessment to Extend the Supersonic Speed Waiver for Continued Operations in the Black Mountain Supersonic Corridor and Alpha Corridor/Precision Impact Range Area* (AFFTC 2001). A FONSI was completed for that EA which established that supersonic flight activity up to 740 flights annually would not create a significant impact on natural resources in the area.

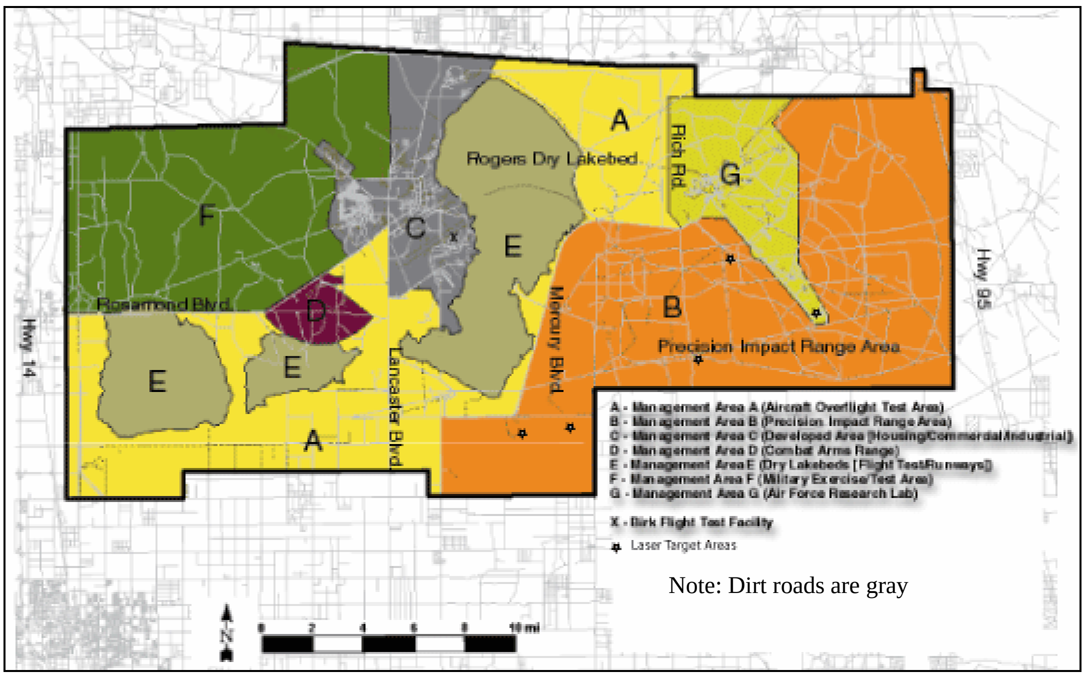


Figure 4-3 Location of Laser Target Areas in the Management Areas

Ground-to-air testing would use designated FPs on the PIRA, AFRL, or other management areas that have been evaluated and approved for use by 95 ABW/CEV Environmental Management. Mitigation measures would be required to verify that a target area had been evaluated for sensitive, threatened, or endangered species. If appropriate, a new site will be selected that does not contain sensitive, threatened, or endangered species or the site would be mitigated after coordination with USFWS. Airborne targets would be located in the airspace above Edwards AFB that is within restricted area R-2515 over Edwards AFB.

Chemical Effects on Natural Resources

Under normal conditions, there would be no significant hazardous materials or hazardous waste impacts on natural resources. Aircraft emissions, and potential LGACs created during high power lasing, would be dispersed in the atmosphere above the mixing layer of 3,000 feet AGL (except for 5 percent of the test events) and reduced to non-hazardous concentrations (AFFTC 2003). For the test events below 3,000 feet AGL, the aircraft emissions and LGACs would be dispersed by the typical surface winds which are west-southwest to southwest at 8 miles per hour (NASA 1997b). The primary hazardous contaminants likely to be released from the use of a laser system would be similar to those released by the COIL on the ABL. Transformational systems using the COIL or its variant forms would use chlorine (Cl_2) and iodine (I_2). Exposure to these hazardous elements could directly affect the respiratory tract in wildlife species and create eye irritation. Exhaust gases from the chemical reaction would be passed through a scrubber that removes 95 percent of the waste products. The wastes thus generated would be removed according to standard operating procedures and would not directly or indirectly affect the environment (AFFTC 2003).

Plants

Many plant species, including plant species not protected under the ESA, are discussed here because they are considered "sensitive" by federal, state, or other agencies/organizations. Some of these species are former candidates for federal and state listing. As such, substantial research has been previously committed and they are subjects of ongoing study and monitoring. Section 3.9.1.1 summarizes these plant species, and a detailed analysis can be found in the INRMP (Edwards AFB 2004). Ground-disturbing activities have the potential to impact ground-dwelling plant communities as well as sensitive plant species. These impacts may be direct by physically killing individuals or indirect by disturbing habitat or otherwise creating conditions which are adverse to species success.

Plant Communities

Impacts on plant communities from flight and ground activities associated with implementing the proposed action are primarily associated with ground disturbing activities such as trenching, grading, off-road vehicle traffic, and target maintenance. The total area potentially impacted would be less than 100 acres for all target areas. Project activities would occur at one of the five established LTAs or at controlled areas or new targets where 95 ABW/CEV Environmental Management Division biologists have determined that significant impacts to any of the five major plant communities are not likely to occur. Each of the LTAs is less than 5 acres and new target areas would be limited to 5 acres each where target boards, vehicles, or other types of targets would be positioned for test and evaluation events. The largest existing target boards (Figure 4-4) (one of the designated LTAs adjacent to the Downfall Complex) is 50 feet wide and 30 feet tall.

Figure 4-4 Example of an Existing Target Board

A series of dirt roads leading to the target areas, as shown on Figure 4-3, are graded and remain devoid of vegetation. Joshua Tree Woodlands and Creosote Bush Scrub plant communities dominate the land features around the target areas, which are also routinely graded and generally clear of these species. During test activities, off-target lasing or reflections coming in contact with the plants would probably result in the destruction of part or all of an individual plant or small group of plants. Considering that the laser beam would be less than 18 inches in diameter (in the case of the ABL COIL and similar COIL lasers), the potential for affecting these plant communities would be limited to a small area if the laser missed the ground target or target board at the LTA. If all the plants in the target area were lased and subsequently eradicated, less than two-thousandths of the total Joshua Tree Woodlands plant community and less than one-thousandth of the Creosote Bush Scrub plant community on Edwards AFB would be impacted. As such, the impacts on these plant communities would be less than significant.

The proposed project would not require the removal of vegetation other than removal authorized at the proposed LTAs, FP, and access roads.

Sensitive Plant Species

The alkali mariposa lily and desert cymopterus have been documented to occur within the PIRA. During species surveys for desert cymopterus at Edwards AFB, plant communities of this sensitive plant species have not been found on previously graded target areas; however, since surveys were not conducted during wet years, the presence of these species cannot be completely ruled out. Based on experience from past surveys, 10 inches of rainfall would be necessary to eliminate all changes on this species from occurring in the target areas. While these sensitive plant species are known to be in the PIRA they are not known to be at the LTAs. Mitigation measures to ensure these sensitive plant species are not affected are addressed below.

Wildlife

Except for birds and bats (at night) in flight, potential impacts on wildlife from laser testing events would only be associated with ground activities.

Impacts from ground activities associated with implementing the Proposed Action would be primarily associated with ground disturbing activities such as trenching, grading, off-road vehicle traffic, and target construction/maintenance. The total area potentially impacted would be less than 100 acres for all target areas. Project activities would occur at one of the five proposed LTAs or at controlled areas or new targets where 95 ABW/CEV Environmental Management Division wildlife biologists have determined that significant impacts to any of the species as identified in Section 3.9.1.2 are not likely to occur. Each of the LTAs is less than 5 acres, and new target areas would be limited to 5 acres each where target boards, vehicles, or other types of targets would be positioned for test and evaluation events. A series of dirt roads leading to the target areas, as shown on Figure 4-3, would be graded and kept clear of vegetation and habitat for wildlife species.

Individual members of the various wildlife species found in Region 1 could be affected by the laser beam if they were in the path of the beam. Depending on their exact location at the time of lasing, wildlife could be injured or killed. To minimize the potential impacts to wildlife, the mitigation measures addressed in Section 4.9.4 would be followed.

Species of shrimp found in the Rogers Dry Lake area lie dormant in the dry soil (AFFTC 1992). During the rainy season when flooding creates the aquatic habitat necessary for them to complete their life cycles, testing would not occur on the lakebeds. Currently no LTAs or FPs are located on Rogers Dry Lake.

When new LTAs or FPs are identified 95 ABW/CEV wildlife biologist will evaluate the site to ensure the selection would not have a significant impact on the shrimp. Since these species are not found at the designated LTAs, the potential for being lased or impacted would be unlikely.

Amphibians like the western toad, Pacific tree frog, red spotted toad, and African clawed frog typically found at Piute Ponds are more than 10 NM from the LTAs which is outside the LHZ; thus it is unlikely these species would be affected by laser test and evaluation events.

Common reptiles like the desert spiny lizard, side blotched lizard, western whiptail, and zebra-tailed lizard, are highly mobile. The glossy snake, coachwhip, gopher snake, and Mojave green rattlesnake may be around the target areas and individuals may be lased, but due to the short duration of each lasing event and the mobility of these species, the probability that more than one individual of the species would be affected would be low.

Known non-migratory bird species like the turkey vulture, common raven, sage sparrow, barn owl, house finch, and western meadowlark could perch or roost on the target boards or other targets at the LTAs. Individual birds may be lased and subsequently injured or killed if they are sitting on the target or close enough to the target for the reflected beam to contact them; however, the lasing, which is extremely accurate, would be focused on the center of the target. Additional safeguards including administrative controls as addressed in Section 4.12.3.2 would be implemented to minimize off-target lasing. Analysis has also shown that the potential for the reflected beam to contact specific objects is affected by the properties of the target surface and geometry of the targeting solution (Haber and Larson 2006). Consequently, the potential for lasing any bird species that had perched on or near the targets is unlikely. Additionally, since the LTAs would be graded to remove the vegetation and food sources from the immediate target areas; the probability of these species utilizing these areas would also be expected to be limited. Since most lasing events would only last up to 10 seconds, birds typically do not perch on flat surfaces perpendicular to the ground (no place to stand or roost), and the center of the target could be between 23 to 148 feet from the top of the target board (a separation of over 20 feet to where the birds could perch), birds would not be likely to be lased by a beam that is 18 inches in diameter. For most of the A/A testing, lasers would be aimed from the targeting aircraft in Region 1 or Region 2 at target boards attached to the Proteus aircraft or other A/A targets above 3,000 feet AGL in the airspace over Edwards AFB.

Since typically less than 1 flight per week (5 percent of the flight tests) would occur below 3,000 feet AGL, noise and visual impacts on wildlife would be less than significant. Studies on noise and visual effects from aircraft tests above 3,000 feet AGL have shown that wildlife habituate or are not affected by aircraft operating at these altitudes. There would be an incremental increase in the number of flights over the duration of the program; however, the total number of flights at Edwards AFB would remain about the same (see Section 4.15, Cumulative Impacts). Studies on the effects of noise on wildlife caused by aircraft overflights and impulse noise such as sonic booms have been focused on birds, including raptors, bighorn sheep, and small mammals (Oak Ridge National Laboratory [ORNL] 2000). Bighorn sheep are not known to be found in Region 1. It has been shown that occasional, low-altitude overflights can produce increased heart rates in hoofed mammals, but the effect was not found to be detrimental and in most cases animal habituate to the noise. Low-altitude military overflights have the potential to impact the hearing thresholds of some rodent species. Birds, on the other hand, appear to be unaffected by both the low-level aircraft overflight noise and sonic booms (ORNL 2000).

Mitigation measures to minimize the effect on non-migratory birds will be addressed in Section 4.9.4.

Sensitive Wildlife Species

Ground-disturbing activities such as establishing and maintaining FPs and LTAs have the potential to impact desert tortoises, as well as other ground dwelling species like the Mohave ground squirrel. These impacts may be direct by physically injuring or killing individuals or indirect by disturbing habitat or otherwise creating conditions which are adverse to species success. Other effects would include laser beam scatter from reflected surfaces and laser beams traveling beyond the backdrop and into animal habitat areas. Lasing activities would be pulsed for a short duration and would have short-term impacts on biological resources.

Prior to lasing in the A/G or G/G modes, visual inspection of the LTA would be accomplished or tortoise fences would be installed around the LTA to verify that natural resources, particularly the desert tortoise, are not located in the LTA. Compliance with the INRMP would minimize any potential impact as would adhering to established testing procedures and the suggested mitigation measures as outlined in this EA. Establishing LSZs would also minimize the indirect effect of laser activities on the desert tortoise and Mohave ground squirrel. Edwards AFB is developing a basewide biological assessment as a primary objective in support of the Section 7 consultation process. Management of threatened and endangered species at Edwards AFB is based on compliance with measures contained in the ESA, Sikes Act, and terms and conditions of the various biological opinions issued by the USFWS, including undertaking measures necessary to minimize incidental take of desert tortoises.

Anthropogenic noise can impact desert tortoises in several ways including damage to the auditory system and disruption of communication. Noise studies on tortoises have shown very little behavioral or physiological effect on tortoises from loud noises that simulated jet overflights or sonic booms (USGS 2001). Desert tortoises appear to be unaffected by noise even up to levels over 100 dBA (U.S. Army 2004a). Subsequently, noise produced by laser test and evaluation aircraft is not expected to affect desert tortoises on Edwards AFB.

Active management of desert tortoises affords some protection for the Mohave ground squirrel. Known populations of the Mohave ground squirrel are located within 2 miles of the LTAs at Mt. Mesa, Grinnel, and the existing target board south of Downfall. Although the Mohave ground squirrel has been found in the area it has not been seen at the LTAs (Edwards AFB 2004). Aircraft noise and equipment noise may be sufficient to cause a startle response from the Mohave ground squirrel, but there is no evidence in the literature to suggest adverse impacts to this species or small mammals in general. Potential impacts on wildlife species would be minimized by implementing beam control techniques, conducting visual sweeps of the FPs and LTAs on Edwards AFB, and other administrative controls to ensure the beam is focused on the intended target.

Sensitive Habitats

Edwards AFB provides sensitive habitat for one permanent resident species listed under the ESA, the desert tortoise (Edwards AFB 2002). As noted above, ground disturbing activities have the potential to impact the sensitive habitats of desert tortoise as well as other ground dwelling species. Most sensitive habitats in Region 1 have compatible land uses that do not notably degrade these areas. Threats to natural sensitive habitats are greater from unauthorized off-road vehicle use, now managed in part by fencing and security police patrols (Edwards AFB 2004). Impacts may be direct by physically injuring or killing individuals or indirect by disturbing habitat or otherwise creating conditions which are adverse to completion of a species life cycle. Vegetation provides cover, feed, and shade among other key factors necessary to the success of the species. Furthermore, vegetation removal is known to result in soil erosion and contribute to flooding through alteration of water courses. Such changes to natural movements of soil and water can result in impacts to ground-dwelling species; however the 5-acre areas for the proposed LTAs would not be expected to pose a significant impact because the LTAs are small, and mitigation measures would minimize any long-term effect.

During lasing activities, the laser beam could potentially affect animal habitat if habitats are within the laser beam zone. Other effects would include laser beam scatter from reflected surfaces and laser beams traveling beyond the backdrop and into animal habitat areas. Lasing activities would be pulsed over a short duration and would have short-term impacts on these habitats.

The Proposed Action would not require the removal of vegetation except as authorized for road grading and road maintenance or to clear the area around the established FPs and LTAs. If required, construction activities associated with erecting new target boards would include digging holes for support poles and assembling the target boards at the LTAs; however most of the target boards and data collection arrays would be mobile so they could be used at the various LTAs depending on test plan requirements. Vehicles transiting to the LTAs and FPs would use established roads and procedures for operating in these sensitive habitat areas. This would result in a short-term impact to wildlife in the target area during the period of construction and an intermittent impact when the target areas were checked following the laser test event. Less than 5 acres at each LTA and less than 100 total acres would be affected.

Designated Critical Habitat

The Proposed Action would occur within critical desert tortoise habitat. Within critical habitat, desert tortoise population densities are higher than those typically found in other areas on Edwards AFB. Therefore, the probability of encountering desert tortoises is comparatively higher in these areas. Project activities also have the potential to negatively impact areas within critical habitat through temporary and/or permanent habitat disturbance. Approximately 1.0 percent of the critical habitat for the desert tortoise identified by the DWMA occurs on Edwards AFB. This critical habitat is located on the eastern and southeastern portion of Edwards AFB and includes portions of the AFRL and PIRA. Using these target areas would remove less than 0.0008 percent of the total designated critical habitat. Because so little habitat would be removed, the Proposed Action would not result in fragmentation of this resource even if the test sites were maintained for future use by other programs.

In the *Biological Opinion for the California Desert Conservation Area Plan* (1-8-03-F-58), a 1 percent threshold for new ground disturbance for the 30-year life of the plan was established. This would include any clearing, excavating, grading, or other manipulation of the terrain, whether or not a permanent use is proposed for the site. Allowable ground disturbance for the desert tortoise wildlife management areas is 13,000 acres. Therefore, disturbance of up to 100 acres total for the Proposed Action would equate to less than a 0.4 percent removal of allowable ground disturbance (U.S. Department of the Interior 2006). This critical habitat consists of creosote bush scrub and Joshua tree woodland habitats, although other habitats, including xerophytic and halophytic saltbush and mesquite woodland, are also represented.

Biological opinions applicable to the proposed laser testing program would include *Biological Opinion for Routine Operations and Facility Construction within the Cantonment Areas of Main and South Bases, Edwards Air Force Base, California (1-6-91-F-28)* (USFWS 1991) and *Biological Opinion for the Precision Impact Range Area, Edwards Air Force Base, California (1-8-94-F-6)* (USFWS 1994a). These biological opinions would apply to DE tests conducted at PB-1, 8, 9, 10, 11, and 12. Mitigation measures derived from these Biological Opinions that will be implemented to minimize impacts on designated critical habitat are addressed in Section 4.9.4. Additionally, a basewide biological assessment is being developed to support the Section 7 consultation process with the USFWS.

Desert Tortoise Management Zones

The greatest potential for impact on the desert tortoise resulting from project activities is likely to occur when project personnel and vehicles are driving on the dirt roads to the target sites. Zone 3 Desert Tortoise Management Area encompasses 30,360 acres on the PIRA. Three potential laser target sites, Mt. Mesa, Haystack Butte, and Mt. Grinnel, are within a designated desert tortoise critical habitat, Zone 3 Desert Tortoise Management Area (see Figures 3-12 and 3-13). Removal of 15 acres (3 sites at 5 acres each) would result in a less than 0.049 percent reduction in critical habitat in Zone 3. Under the Biological Opinion (USFWS 1994a), individual projects are limited to 5 acres with a maximum total disturbance of 100 acres including the area of access roads. Individual LTAs for the Proposed Action would be limited to 5 acres with a maximum total disturbance of 100 acres. To minimize potential impacts, targeting boards and targets would be transported along existing roads. Targets and transport vehicles would be positioned on existing roads to minimize further risk of ground disturbance. Avoidance of siting targets in Zone 3 would be considered to the maximum extent feasible. Because vegetation at the five selected target areas would be removed, tortoises would not normally be expected to be present on the FP or LTA, but could occasionally transit through the area. Desert tortoises mate in the late spring and the early summer (usually April to July). The tortoises are most active in California during the spring and early summer when annual plants are most common. Additional activity occurs during the warmer fall months and occasionally after summer rainstorms. Desert tortoises spend the remainder of the year in burrows, escaping extreme desert conditions (Edwards AFB 2002). Tortoise population densities were found to be low to very low throughout Edwards AFB, and approximately 80 percent of the base has densities at or below 20 tortoises per 1 square mile (Edwards AFB 2002).

Sensitive Ecological Areas

Laser test events would not occur in or over the two SEAs on Edwards AFB.

Migratory Birds

During flight tests (A/A, A/G, and G/A), project personnel may encounter migratory birds and would comply with all measures in the *Migratory Bird Treaty Act* (MBTA) and EO 13186. The United States Government is exempt from the MBTA permit requirements, but must minimize take caused by its activities. During nesting season, the base biologist would survey the target sites for raptor nests. If a nest was found on the target it would need to be moved prior to any planned test event. Edwards AFB has a depredation permit which allows a nest to be moved, thus minimizing impacts on the nest that could occur during lasing of the target.

In general, birds fly below 3,000 feet AGL except during migration. Vultures sometimes rise to over 10,000 feet (Stanford Alumni 2005). Long-distance migratory bird species start out at about 5,000 feet and climb to around 20,000 feet. Migratory birds would not be found at heights above 35,000 feet AGL.

The Air Force considers BASH a safety concern for aircraft operations. The BASH hazards are managed to reduce the probability of a bird/aircraft impact. Most birds typically fly at altitudes below 2,500 feet AGL. Since most test aircraft would be operating above 3,000 feet AGL, except for 5 percent of planned tests and during aircraft takeoff and landing, the potential for impacts on test aircraft and birds would be the same as for other testing and evaluation aircraft missions. Methods used at Edwards AFB to control the bird air strike problem include the use of horned larks and use of a falconer, selective revegetation around the runway with native plants, and pilot notifications when there is a high concentration of birds in the immediate area. Therefore, the likelihood of a BASH incident is considered low.

While there may be occasional bird collisions with test aircraft, primarily during low-altitude lasing events, there would be no significant impacts on bird species or other wildlife during laser air flight test activities. Aircraft would be flown to avoid migratory bird corridors during periods of seasonal migrations and in accordance with established flight procedures. There would be no laser testing in the A/G and G/A modes conducted over areas of critical concern in Region 2 as shown in Figure 3-13.

Cliffs and rocky outcrops could provide nesting and roosting habitat for cliff dwelling birds. These topographic features are relatively scarce on Edwards AFB. Therefore, avoidance of these areas can be crucial to the success of certain species. Birds such as the peregrine falcon and prairie falcon may rely heavily on these areas for nesting, perching, foraging, and roosting habitat at Edwards AFB. Many of these species become very territorial and are easily disturbed by human presence during their reproductive cycles. Furthermore, many of these species receive protection through the ESA, MBTA, and/or state laws. Since the rocky outcropping at Haystack Butte is planned as a backdrop for the LTA, off-target lasing could in injure or kill birds at this location. This constitutes a potential impact to wildlife. Considering the duration of the actual lasing event and considering that the lasers will primarily be aimed at the target boards and other targets located in front of the outcropping, and that administrative controls will be used to minimize off-target lasing, the probability that the laser beam would lase any wildlife at Haystack Butte is remote. Mitigation measures that further reduce the potential for lasing of wildlife at this location are addressed in Section 4.9.4.

4.9.1.2 Flight and Ground Test Activities—Region 2

Flight Test Activities

Any potential impacts on natural resources in Region 2 would be flight-related because there are no planned ground-related activities in this region. Flight-related activities in Region 2 could potentially impact migratory/non-migratory birds; however, as addressed above, BASH procedures would be utilized to minimize any potential impacts. Bats could also be affected during flight activities occurring at dusk and during the nighttime hours when they forage for food. Mitigation measures for flight test activities are addressed in Section 4.9.4.

Ground Test Activities

Ground test activities are not proposed or anticipated to occur in Region 2; subsequently, no impacts or mitigation measures would be required for ground-related activities in Region 2.

4.9.2 Alternative B (Limited Capability)

Natural resources potentially affected by implementing Alternative B would include impacts on plants, plant communities, azonal habitats, sensitive plant species, wildlife, sensitive wildlife species, sensitive habitats, designated critical habitat, desert tortoise management zones, and SEAs as discussed for Alternative A. The types of potential effects would include ground disturbing activities, noise, chemical exposure, visual exposure to aircraft and test equipment, and aircraft and test equipment contact with wildlife and migratory birds.

4.9.2.1 Flight and Ground Test Activities—Region 1

Flight Test Activities

Except for the potential impacts of the laser beam on natural resources in Region 1, the potential impacts resulting from implementing Alternative B flight test activities would be identical to those identified under Region 1 for Alternative A.

For low power A/A lasing, targets would be located in restricted area R-2515 over Edwards AFB. Aircraft firing toward the A/A target could be at other locations within the R-2508 Complex.

Under Alternative B, aircraft would operate at supersonic speeds; however the flight profiles would only occur in the Black Mountain Supersonic Corridor or Alpha/PIRA Supersonic Corridor or above 30,000 feet above MSL (FL 300) in accordance with AFI 13-201, *U.S. Air Force Airspace Management*. Except for a small northwest portion of the Black Mountain Supersonic Corridor, both of these corridors are within R-2515 restricted airspace. Potential noise impacts on natural resources associated with flight tests in these corridors are addressed in the *Environmental Assessment to Extend the Supersonic Speed Waiver for Continued Operations in the Black Mountain Supersonic Corridor and Alpha Corridor/Precision Impact Range Area* (AFFTC 2001). A FONSI was completed for that EA which established that supersonic flight activity up to 740 flights annually would not create a significant impact on natural resources in the area.

For flight test activities involving A/G and G/A laser test and evaluation, impacts and procedures to minimize disturbance on Region 1 natural resources would be similar to those addressed for Alternative A. Similarly, air-to-ground lasing would be directed at targets at one of the five proposed LTAs established on the PIRA or other management areas approved for use. Because testing under Alternative B would be limited to low power levels (like current surrogate laser sources, which project the energy from a 10–14 W source with an effective power of less than 1 W when it leaves the device) (Montoya 2005), impacts caused by lasing would be less than potential impacts identified under Alternative A.

Ground Test Activities

Since ground test activities would be similar to flight test activities, except for the potential impacts of the laser beam on natural resources in Region 1, the potential impacts resulting from implementing Alternative B ground test activities would be identical to those identified under Region 1 for Alternative

A. As such, the same mitigation measures would be required and implemented as addressed in Section 4.9.4.

4.9.2.2 Flight and Ground Test Activities—Region 2

No direct impacts on Region 2 natural resources would be anticipated as a result of implementing Alternative B. Flight tests would be conducted at altitudes established and approved in the test plan. Any altitude restrictions would be established based on FAA requirements. For most A/A testing, lasers would be aimed from the targeting aircraft to target boards attached to the Proteus aircraft. For laser testing in the G/A and A/G modes, the ground based FPs and LTAs would be located on Edwards AFB. Supersonic tests would not occur in Region 2; therefore, sonic boom impacts on natural resources in Region 2 would not occur as a result of implementing Alternative B.

Laser testing in the G/A, G/G, G/S, and S/G modes would not be conducted in the portions of Region 2 that lie outside of Region 1.

Aircraft would be flown to avoid migratory bird corridors during seasonal migrations. There would be no laser testing in the A/G and G/A modes conducted over special management areas in the R-2508 Complex.

Impacts on Region 2 natural resources would be less than significant if Alternative B were implemented.

4.9.3 Alternative C (No-Action Alternative)

Under the No-Action Alternative, no new laser test missions other than those previously approved under the Airborne Laser Program would occur (AFCEE 2003; U.S. Air Force 1997). Aircraft using the R-2508 Complex would continue to comply with approved flight profiles and missions per applicable DoD, Air Force, and AFFTC instructions. There would be no additional impacts on natural resources resulting from the No-Action Alternative. No additional mitigation measures beyond those described in the ABL environmental impact statements would be required if Alternative C were implemented.

4.9.4 Mitigation Measures

Biological surveys will be conducted prior to establishing LTAs and FPs on the PIRA, AFRL, or other management areas. Potential impacts on plant species and habitat will be minimized by limiting the area disturbed to the 5-acre LTAs and maintenance of the access roads to those target areas. Test plans will indicate requirements for range and test personnel to remain on the graded areas to the maximum extent possible and to comply with conditions of the INRMP as they apply to these areas.

Project personnel will be briefed by 95 ABW/CEV biologists on the Desert Cymopterus Education Awareness Plan as well as any new species of concern. Biological assessments will be conducted for any new LTAs and FPs on the PIRA, AFRL, or any of the other management areas to ensure any sensitive species are not permanently impacted by the proposed project activities.

Potential impacts on wildlife species will be minimized by implementing beam control techniques, conducting visual sweeps of the FPs and LTAs on Edwards AFB before test events, erecting tortoise fences, and implementing other administrative controls (as addressed in Section 4.12.3.2) to ensure the beam is focused on the intended target. BASH avoidance techniques will be used to minimize any potential impacts on birds in the target areas.

Desert tortoises found within the project area will be removed from LTA(s) and firing points and placed in outdoor desert tortoise pens located in a natural environment for up to 7 consecutive days. If tortoise fences are installed around the LTA(s) and firing points, then this removal from the LTA(s) and firing points will be permanent. This removal action will constitute a short-term effect to the tortoises and will be reported to the USFWS. Relocating the tortoises out of harm's way will reduce the potential for disruption of their natural routine but may have long-term negative effects on local populations.

The following are examples of mitigation measures that will be applied, as appropriate, for G/G, A/G, and G/A laser test and evaluation activities to protect the desert tortoises.

(1) All workers and visitors to work sites will receive a desert tortoise awareness briefing that defines their responsibilities and liabilities under the ESA. Project personnel will notify 95 ABW/CEV, Environmental Management Division, at least 3 days prior to starting project activities to schedule briefings, pre-surveys, and monitoring.

(2) If a desert tortoise burrow is encountered within the LTA, the burrow will be avoided to the maximum extent practicable. If avoidance is not possible, an authorized AFFTC biologist will excavate the burrow according to the USFWS *Guidelines for Handling Desert Tortoises During Construction Projects*.

(3) Desert tortoises found aboveground within the project area will be temporarily moved out of harm's way by an authorized biologist according to the USFWS *Guidelines for Handling Desert Tortoises During Construction Projects*.

(4) During construction activities areas will be clearly fenced, marked, and flagged at the outer boundaries to define the limits of work activities. All workers will be instructed to confine their activities to the marked areas.

(5) Laydown, parking, and staging areas will be restricted to previously disturbed areas to the maximum extent practicable.

(6) Vehicles will, to the maximum extent practicable, remain on established roads. If this is not possible in the project area, an authorized biologist will survey the route to be traveled. Equipment and vehicle operators will be alert for desert tortoises and other wildlife in and along access routes. All desert tortoise burrows will be avoided during off-road travel. When traveling off-road, speed limits will not exceed 5 miles per hour and shrubs will be avoided as much as possible.

(7) At no time will project personnel or site visitors harass, harm, or kill any desert tortoise. Project personnel or site visitors will not touch or move any desert tortoise unless the tortoise is in danger of being killed or injured; and then only if they have been properly instructed and trained how to properly handle and move the desert tortoise and if a Base Biologist cannot be located. Workers and visitors will immediately report all desert tortoise sightings to 95 ABW/CEV, Environmental Management Division.

(8) Workers and site visitors will check under parked vehicles for desert tortoises and other wildlife species before moving vehicles. If a desert tortoise is found under a vehicle, the 95 ABW/CEV, Environmental Management Division, will be notified immediately so an authorized biologist can move the desert tortoise to a safe area.

(9) All trash will be placed in raven-proof receptacles for proper disposal to reduce its attractiveness to desert tortoise predators (e.g., coyotes and common ravens).

(10) All open excavations will have a ramp with a 3:1 slope at each end to facilitate escape of trapped wildlife. Excavations left overnight will be secured prior to leaving the site. Exclusionary fencing or plywood may be used to prevent wildlife from becoming trapped

in excavations. Excavations will be inspected for trapped wildlife prior to backfilling. If any wildlife is trapped in excavations at work sites, the 95 ABW/CEV, Environmental Management Division, will be notified immediately.

(11) Stationary laser target boards will be inspected for active bird nests prior to lasing activities.

(12) Contact the 95 ABW/CEV, Environmental Management Division, at (661)275-2435 or (661)277-2017 if an active bird nest is found within the project area.

(13) The total allowable cumulative habitat disturbance for project activities located in Desert Tortoise Management Area Zone 3 is 100 acres. Siting targets and conducting projects within Zone 3 will be avoided to the maximum extent feasible.

Laser targeting activities will only be performed at LTAs approved for use by 95 ABW/CEV Environmental Management, Bioenvironmental Engineering, and Range Safety Office and only after all other safety parameters are met.

4.10 NOISE

Noise impact criteria are based on land use compatibility guidelines and on factors related to the duration and magnitude of noise level changes. Annoyance effects are the primary consideration for most noise impact assessments. Because the reaction to noise level changes involves both physiological and psychological factors, the magnitude of a noise level change can be as important as the resulting overall noise level. The local residents would often consider a readily noticeable increase in noise levels a significant effect, even if the overall noise level was still within land use compatibility guidelines. On the other hand, noise level increases that are unnoticed by most people are not considered a significant change, even if the overall noise level is somewhat above land use compatibility guidelines. Some potentially significant thresholds include the following:

- An L_{DN} of 65 dBA, or a CDNL of 61 C-weighted decibels (dBC) for sonic booms, is the generally accepted limit for outdoor noise levels in residential areas for land use planning and long-term annoyance factors (U.S. Army 2001). Project-related noise levels 5 dB or more above 65 dBA or above 61 dBC would be considered a significant impact.

- Frequent occurrence of a CSEL greater than the generally accepted limit for outdoor noise levels of 61 dBC.

- Weapons-related sound levels above 130 dBP pose a high risk of noise complaints with the possibility of damage to windows, bric-a-brac, and plaster.

4.10.1 Alternative A (Desired Capability, Proposed Action Alternative)

4.10.1.1 Noise—Region 1

Flight Test Activities

Fixed-wing aircraft and helicopters (similar to the B747, AC-130, B1-B, H-47, F-22, MV-22, UAV, and associated chase aircraft [T-38, F-15, or F-16]) involved in laser test and evaluation in A/G, G/A, and A/A modes would launch from Runway 22 at Edwards AFB and climb to the appropriate test altitude based on safety and technical requirements. Airborne targets like the Proteus aircraft for A/A and G/A testing would also climb to the appropriate test altitude based on safety and technical requirements. Sound exposure levels and the A-weighted Single Event Maximum Sound Level (L_{max}) for proposed laser test and evaluation aircraft would be similar to those shown in Table 4-6.

Under the Proposed Action, aircraft would operate at supersonic speeds; however, the flight profiles would only occur in the Black Mountain Supersonic Corridor or Alpha/PIRA Supersonic Corridor or above 30,000 feet above MSL (FL 300) in accordance with AFI 13-201, *U.S. Air Force Airspace Management*. Except for a small northwest portion of the Black Mountain Supersonic Corridor, both of these corridors are within R-2515 restricted airspace. Potential noise impacts associated with flight in these corridors are addressed in the *Environmental Assessment to Extend the Supersonic Speed Waiver for Continued Operations in the Black Mountain Supersonic Corridor and Alpha Corridor/Precision Impact Range Area* (AFFTC 2001). A FONSI was completed for that EA which established that supersonic flight activity up to 740 flights annually would not create a significant noise impact in the area.

Up to 170 laser test and evaluation flights would occur annually. The Supplemental Environmental Impact Statement for the Airborne Laser Program states that for 255 test flights the DNL noise exposure at Edwards AFB would increase by 0.8 dBA and the DNL over the ranges would be less than 55 dBA (AFCEE 2003). Considering there would be fewer flights under the Proposed Action, and the fact that noise from these flights would not increase the noise contours at Edwards AFB or the ranges, no noise impacts would be anticipated for flight testing in Region 1.

Table 4-6

Summaries of Sound Levels for Proposed Laser Test and Evaluation Aircraft

	Altitude Above Ground Level					
	500 feet		3,000 feet		10,000 feet	
	SEL	L_{max}	SEL	L_{max}	SEL	L_{max}
Aircraft	dB					
AC-130 [b]	96.2	91.2	81.5	71.9	63.7	51.6
B747 [a]	85.5	85.5	N/A	N/A	N/A	<85
B1-B [b]	128.9	125.5	112.0	104.0	64.7	55.5
F-22 [b]	123.7	119.2	108.0	98.8	82.9	70.3
F-15 [b]	116.9	111.0	101.3	90.8	77.0	70.7
F-16 [b]	112.7	108.5	96.3	87.4	78.2	63.6
H-47 [b]	97.2	87.8	83.4	69.3	67.5	52.4
T-38 [b]	110.7	105.3	92.9	82.8	43.2	27.6
UAV	N/A	N/A	N/A	N/A	N/A	<85 [c]
Proteus	N/A	N/A	N/A	N/A	N/A	<85 [c]

Notes: dB-decibel
L_{max} – A-weighted single event maximum sound level
N/A – not available
SEL – sound exposure level
Sources: a -Port of Oakland 2004 (SEL and L_{max} values are for 100 feet above ground level)
b-U.S. Air Force 2005
c-U.S. Army 2004b

Mitigation Measures

Every effort will be made to minimize the number of sonic booms by controlling supersonic operations to ensure that only mission essential operations are conducted. In addition, the direction of the supersonic flight is controlled to minimize the effect on communities located near the corridors.

Ground Test Activities

Noise generated during ground testing events would result from activities such as vehicles transporting personnel to test facilities, construction of target boards, building earthen berms and enclosures, operating

AGE and GSE, moving laser platforms (self-propelled), and the lasing process. Noise generated by the GPRA (a low-pressure, low-velocity device) during ground testing of the ABL's HEL is expected to be 10 dBA. The GPRA may be available or used to support the ground testing of other laser systems. The associated ejector tubes and turbo-pumps are expected to generate noise levels of approximately 110 to 134 dBA during the 20-second duration of the ground tests. These noise levels would be attenuated by their surrounding environments (the SIL and Building 151); therefore, exterior noise levels would be expected to be lower. For comparison, an 80 dB noise level is equivalent to a gas lawnmower at 100 feet.

Since the Occupational Safety and Health Administration limits impulsive noise or impact noise to less than 140 dB and exposure to a continuous noise of 115 dB to less than 15 minutes (29 CFR § 1910.95), hearing protection would be required for personnel in the immediate vicinity of the GPRA and associated ejector tubes during the ground test activities. Increased noise levels from the use of AGE and other GSE adjacent to the runway during ground testing events would not exceed normal flightline noise levels and would not cause adverse effects to residential areas or the local on-base population (AFCEE 2003). While most people think the laser firing sounds like the noise made by a Star Trek phaser blast, in real life the laser makes no noise at all (*Albuquerque Tribune* 2003).

Vehicle noise levels associated with the movement of the HMMWV-mounted laser would conform to the Interstate Motor Carrier Noise Emission Standards. The drive-by exterior sound level complies with the MIL-STD-1474B of 80 dBA. The noise for a fully loaded HMMWV traveling at 25 miles per hour is estimated to be less than 85 dBA (U.S. Army 2004a) at the crew position. It is well known and reported that the dominant factor in road noise is the interaction between tires and the road surface (for automobiles). The resulting noise level is exacerbated with higher vehicle speeds. Mikami *et al.* investigated a quantifiable relationship between vehicle running speed and sound pressure level. Their work resulted in numerical relationships proportional to 12*Log(V) and 33*Log(V) for vehicle speeds less than 60 kilometers per hour and greater than 60 kilometers per hour, respectively (V = vehicle speed in kilometers per hour). For instance, a passenger car running at 60 kilometers per hour (~38 miles per hour) creates a sound pressure level of 95 dBA, while the same vehicle running at 80 kilometers per hour (~55 miles per hour) creates a sound pressure level of 100 dBA. The team also developed similar relationships for light and heavy trucks. Throughout their work, all relationships were based on the combined effects of engine noise and tire/road noise contributions (Colorado Department of Transportation 2004). Typical A-weighted noise levels for traffic on highways range from 60 dBA to 90 dBA (USACE 1997).

Mitigation Measures

Hearing protection would be required for personnel in the immediate vicinity of the GPRA, associated ejector tubes, and AGE/GSE during the ground test and aircraft launch activities in Region 1.

4.10.1.2 Noise—Region 2

Flight Test Activities

Most Region 2 laser test and evaluation activities would occur above 3,000 feet AGL. Sound levels would be the same as those for flight activities at or above 3,000 feet AGL in Region 1 (Table 4-6). No noise impacts would be anticipated for Region 2 flight activities. Supersonic flight activities would not occur in Region 2.

Ground Test Activities

Ground test activities would not be conducted in the portions of Region 2 that lie outside of Region 1.

Mitigation Measures

Since there would be no significant flight- or ground-related noise impacts for Region 2; no mitigation measures would be required.

4.10.2 Alternative B (Limited Capability)

Flight and Ground Test Activities

The environmental effects of noise resulting from implementing Alternative B would be similar to those described for Alternative A. The same number of flight tests and ground activities would occur under Alternative B as with implementing Alternative A. The potential noise impacts from implementing Alternative B would be the same as for Alternative A.

Mitigation Measures

Hearing protection will be required for personnel in the immediate vicinity of the GPRA, associated ejector tubes, and AGE/GSE during the ground test and aircraft launch activities in Region 1. Although no mitigation measures would be required for Region 2, Edwards AFB would continue to monitor noise complaints as a normal part of community relations.

4.10.3 Alternative C (No-Action Alternative)

Under the No-Action Alternative, no new laser test missions other than those previously approved under the Airborne Laser Program would occur (AFCEE 2003; U.S. Air Force 1997). Aircraft using the R-2508 Complex would continue to comply with approved flight profiles and missions per applicable DoD, Air Force, and AFFTC instructions. There would be no additional impacts on noise resulting from the No-Action Alternative. No additional mitigation measures beyond those described in the ABL environmental impact statements would be required if Alternative C were implemented.

4.10.4 Noise Impacts on Wildlife

No significant noise impacts on wildlife would be expected for flight or ground laser test and evaluation events in either Region 1 or Region 2 (refer to Section 4.9 for a description of potential noise impacts on wildlife).

4.10.5 Mitigation Measures

Edwards AFB regularly monitors noise complaints (which are often just inquiries), which average less than 30 per year (Hagenauer 2005) for activities occurring in Region 1. Although noise complaints associated with laser test and evaluation are expected to be negligible, Edwards AFB will continue to monitor noise complaints as a normal part of community relations.

4.11 PUBLIC/EMERGENCY SERVICES

An impact to public/emergency services would be considered significant if it resulted in slower response times by fire protection services, security services, or medical services or if it resulted in failure of these services.

Under normal laser test and evaluation conditions there would be no significant impacts on public/emergency services as a result of implementing any of the proposed alternatives. All emergencies in Region 1 would utilize resources at Edwards AFB. If simultaneous emergencies occurred, there could be a slower response by fire protective services, security services, or medical services; however the organizations that provide these services routinely evaluate and practice responding to multiple emergency situations, coordinating, and obtaining support from other agencies and services organizations. The environmental effects that would impact public and emergency services if any alternatives were implemented would be less than significant.

4.12 SAFETY AND OCCUPATIONAL HEALTH

A safety impact would be considered significant if it created a potential public health hazards, or involved the use, production, or disposal of materials that pose a hazard to people. The primary safety and occupational health hazards associated with laser test and evaluation activities are biological changes to the eyes and skin. Indirect, non-beam safety and occupational health hazards include fire, collateral radiation, shock, and laser-generated air contaminants.

All laser test and evaluation activities at Edwards AFB must comply with AFOSH Standard 48-139, *Laser Radiation Protection Program*.

4.12.1 Laser Hazards

The ANSI Standard Z136.1, Safe Use of Lasers defines the MPE as "the level of laser radiation to which a person may be exposed without hazardous effect or adverse biological change in the eye or skin." The MPE is primarily a function of the laser wavelength and exposure duration, but will vary based on the pulsed laser output parameters such as pulse width and pulse repetition frequency. Generally, the eye safe exposure limits are lower than skin exposure limits. Once the MPE is determined for a laser, the MPE and output parameters—such as power and beam spread—can be used to determine the eye and skin hazard distances. The eye hazard distance, NOHD, is defined as "the distance along the axis of the unobstructed beam from a laser …to the human eye beyond which the…exposure…is not expected to exceed the appropriate MPE." Laser light is predominantly scattered backwards and forwards, and the hazard is from looking directly into the beam. When the appropriate hazard distance is determined, the allowable pointing angles and obstructions must be analyzed to determine the NOHZ. The NOHZ is a three-dimensional volume of airspace where the level of direct, reflected, or scattered radiation during normal operation exceeds the applicable MPE. Table 4-7 summarizes laser parameters likely to be encountered during laser test and evaluation missions.

The ANSI standard states that the maximum exposure time of 10 seconds provides an adequate hazard criterion (for laser wavelengths between 0.7 and 1.4 µm wavelength range) except for unusual viewing conditions.

Table 4-7

Parameters for Laser Test and Evaluation Events

Laser System	Wavelength (µm)	Wave Form	Lasing Medium	Output Power [c]	Laser Classification [d]	MPE Limits	NOHD
ARS	11.149	Chopped	CO_2	kW	4	0.1 W/ cm^2 [e] 0.1 W/ cm^2 [f]	4 km
BILL	1.064	Pulsed	SS Nd:YAG[a]	kW	4	3.34×10^{-7} J/cm^2 [e] 1.79×10^{-4} J/cm^2 [f]	<50 km[i]
HEL	1.315	CW	Chemical	MW	4	0.0128 J/cm^2 [g] 3.1 J/ cm^2 [f]	NA[i]
TILL	1.0296	Pulsed	SS Yb:YAG[b]	kW	4	1.53×10^{-7} J/cm^2 [e] 1.96×10^{-4} J/cm^2 [f]	<50 km [i]
SHEL	1.319	CW	SS Nd:YAG[a]	W	4	0.0405 W/ cm^2 [e] 9.78 W/cm^2 [f]	<50 km [i]

Notes: a – neodymium:yttrium aluminum garnet
b – ytterbium:yttrium aluminum garnet
c – Exact input power/aperture is classified
d – Classified per ANSI Standard Z136.1
e – Ocular MPE classified per ANSI Standard Z136.1
f – Skin MPE classified per ANSI Standard Z136.1
g – Ocular MPE based on glint reflection exposure of 0.1 second
h – Skin MPE based on glint reflection exposure of 0.1 second
i – Dependent on aircraft range to target
CO – carbon dioxide
CW – continuous wave
J/cm^2 – joules per square centimeter
km – kilometer
kW – kilowatt
µm – micrometer (1/1,000,000 meter)
MPE – maximum permissible exposure
MW – megawatt (1,000,000 watts)
NA – No direct viewing would be possible during HEL test activities
NOHD – nominal ocular hazard distance
SS – solid state
W – watt
W/cm^2 – watts per square centimeter

Source: Air Force Center for Environmental Excellence 2003

The radiating beam from the ARS carbon dioxide laser system referenced above diverges as it leaves the laser, thus the NOHD is easily calculated at 4 kilometers. The other systems (BILL, TILL, SHEL, and HEL) can be focused outside the laser turrets (ABL and ATL), and can be adjusted based on the targeting scenarios. Although the SHEL operates in low power and poses no ocular or skin hazard when it leaves the turret, it can become hazardous at extended range as the spot size becomes smaller. For example, at

12 kilometers from the aircraft the SHEL exceeds the ocular MPE (2 kilometers before to 2 kilometers after the target). For this same example the SHEL becomes hazardous to the skin from 100 meters before to 100 meters after the target area (U.S. Air Force 2000). Hazards analysis based on the ANSI standards shows that at shorter distances the ocular and skin NOHD would be reduced. The average power of the TILL, BILL, and HEL lasers is large enough that these beams are hazardous to the eyes as soon as they exit the laser test and evaluation aircraft. The eye and skin hazard distances vary depending on the range from the aircraft to the target.

4.12.2 Laser Backscatter

Generally, the laser beam is attenuated as it propagates through the atmosphere; often broadening, defocusing, and even deflecting from the initial axis toward the target. The attenuation and deflection or scatter depend on the wavelength of the laser, output power, atmospheric makeup, and day-to-day atmospheric conditions (Weichel 1990). However, laser light is predominantly scattered backwards and forwards, with little scatter projected sideways (Keppler 2002). Generally three types of atmospheric scattering occur

- *Rayleigh scattering* is best known as the scattering effect that results in the sky being a blue color. Blue light's shorter wavelength causes it to get scattered around 10 times more by oxygen and nitrogen molecules than the longer red wavelengths or other colors visible to the human eye.

- *Nonselective scattering* results from the impact of light with large particles such as fog, clouds, rain, or snow.

- *Mie scattering* is caused by the presence of aerosol particles and small water droplets. Attenuation in the spectral region from 0.3 μm to 4 μm resulting from the Mie scattering far exceeds the attenuation caused by Rayleigh and nonselective scattering (Weichel 1990). Atmospheric scattering of the laser light from the BILL, TILL, HEL, and SHEL laser test and evaluation activities would be predominantly caused by Mie scattering.

The scattering effects are managed from a safety and occupational health perspective by establishing an NOHZ for each test scenario.

4.12.3 Alternative A (Desired Capability, Proposed Action Alternative)

4.12.3.1 Safety and Occupational Health—Region 1

The established AFFTC Safety and Occupational Health Programs, to including Hazard Communications, would be followed to reduce the potential for any risk to health and safety from laser test and evaluation activities. Under normal conditions, because construction of new facilities would not be required for the program, impacts to on-base safety and occupational health for non–project-related personnel would not occur.

Flight Test Activities

The primary hazard associated with flight test activities would be the laser energy reflected off the target. At Edwards AFB, A/A laser test and evaluation activities would use the Proteus aircraft with mounted target boards. Air-to-air laser engagements would occur at altitudes above 35,000 feet above MSL with the Proteus target aircraft above that altitude (approximately 40,000 feet above MSL), thus eliminating the potential for public exposure to the hazardous levels of direct laser energy. The reflection hazard distance for the HEL laser for airborne targets (calculated for missile tests) has been calculated to be less than 500 meters (U.S. Air Force 2002b). Potential indirect safety and occupational health flight hazards would include fire, shock or electrocution, collateral radiation, and LGACs.

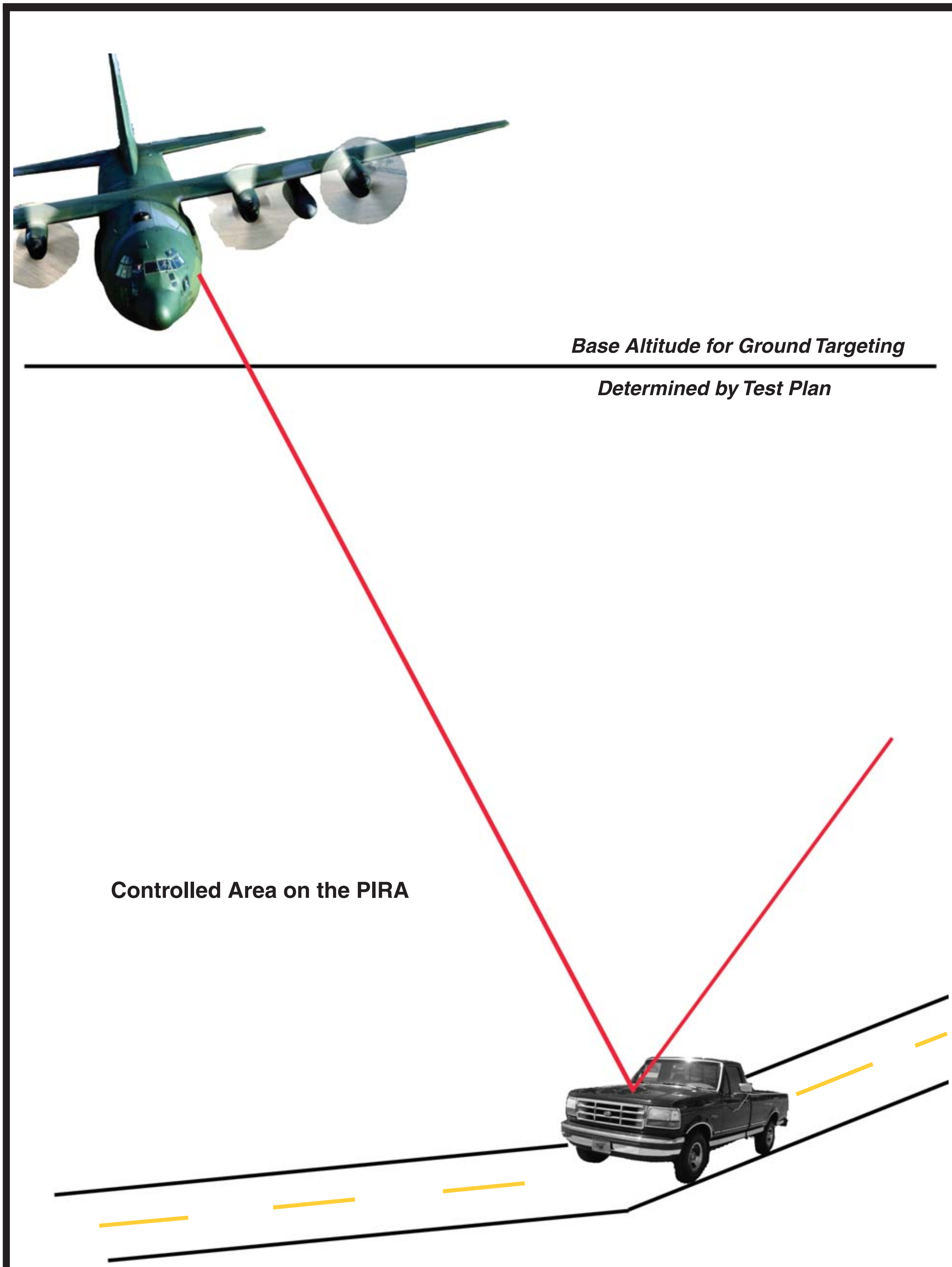
The irradiance of objects from Class 4 lasers presents a fire hazard. For A/A laser test and evaluation activities, the target boards mounted on the Proteus aircraft would only be radiated at low to medium power levels, minimizing the potential for fire. For A/G laser test and evaluation activities, the target boards and rotoplanes would be constructed of flame retardant materials, as defined by the National Fire Protection Association, thus reducing the potential for fires in the target area. For A/G targets as shown in Figure 4-5, the intent of the laser test and evaluation event would be to stop a gasoline fueled vehicle; creating a fire in the engine compartment would be a collateral effect that is expected to occur. Control measures would limit the potential for any resulting fires to the immediate target area, which is generally devoid of additional combustible materials (the surface area surrounding the targets are graded to remove vegetation and make the target more visible during test missions).

The power sources used to create the laser-beam could create a shock or electrocution hazard. Since qualified electricians and trained personnel would be working on these systems the possibility of shock or electrocution is extremely remote. Wiring and electrical support for flight test activities would be contained in the aircraft. As such, electrical exposure to personnel other than those directly associated with the project should not create any significant impacts.

The potential for collateral radiation or black-body radiation (ultraviolet or blue light) produced as a result of air breakdown at the laser-target interface would not present an immediate hazard to personnel. Since personnel would not be within the immediate lasing area, and protective goggles would be worn by flight crews and project personnel, no collateral radiation hazards should exist during laser ground test activities. Once lasing activities ceased, collateral radiation (if any) would cease, and no residual collateral radiation would remain (AFCEE 2003).

The quantity, composition, and chemical complexity of LGACs depend greatly on beam irradiance. When the target irradiance reaches a given threshold, at approximately 10 MW/cm^2, target materials, including plastics, composites, and metals may liberate toxic and noxious airborne contaminants. Airborne contaminants can be generated when certain Class 4 laser beams interact with matter (Laser Institute of America 2003). LGACs would not be created during low-power testing. Target boards would be equipped with infrared sensors used to detect the laser beam(s). Sensor data would be transmitted electronically to the test command and control center. Since LGACs would only be created during high-power lasing events, the command center could terminate the lasing activities if necessary to prevent human exposure. The Bioenvironmental Engineering office (95 AMDS/SGPB) would ensure the industrial hygiene characterizations of exposure to LGACs were used as required by 29 CFR Part 1900.1000, *Air Contaminants*, and AFOSH Standards 48-8, *Controlling Exposure to Hazardous Materials*; this would ensure no occupational overexposure to LGACs occurred. The controlled access to the remote target areas on-base would further reduce the potential for LGACs to create any significant impact. During A/A flight tests, LGAC contaminants would be dispersed in the atmosphere above the mixing layer and reduced to non-hazardous concentrations.

For A/G test scenarios, the direct laser-beam NOHDs for unrestricted lasing using systems such as the BILL, TILL, and HEL could be expected to extend far beyond the target (possibly greater than 6 miles) (AFCEE 2003). The NOHZ would be represented by a hemisphere or dome extending out into free space above the target area to an altitude equal to the appropriate NOHD and with the ground serving as the impermeable floor of the dome.



Potential ATL Air-to-Ground Target on the PIRA	Figure 4-5	Q242-03	1/06/05

The Air Force considers BASH a safety concern for aircraft operations. The BASH hazards are managed to reduce the probability of a bird/aircraft impact. Most birds typically fly at altitudes below 2,500 feet AGL. Since most laser test and evaluation aircraft would be operating above 3,000 feet AGL except during takeoff and landing, the potential for impacts to laser test and evaluation aircraft would be the same as for other non-laser test and evaluation aircraft missions. Methods that have been used at Edwards AFB to control the bird air strike problem include the use of horned larks and use of a falconer. Therefore, the likelihood of a BASH incident is considered low.

In the event of an accident, AFFTC would be required to comply with Occupational Safety and Health and Administration regulations and follow the AFFTC's established Emergency Response Plan. The crash of test aircraft could cause casualties and loss of property. However, strict guidelines and flight procedures have shown the probability of such an occurrence is extremely low for this type of preplanned event. Historically, there is no information on mission-related aircraft accidents that may have taken place on Edwards AFB and Region 1; however, an estimate of aircraft mishap rates in 1996 suggested that a Class A mishap (a mishap that resulted in at least a $1,000,000 loss or the loss of one life) would occur every 4.28 years. Test aircraft such as the F-15, F-16, and T-38 have annual Air Force–wide Class A mishap rates of 2.53, 4.5, and 1.58 per 100,000 flight hours, respectively. The last recorded Class A mishap occurred at Edwards AFB was in 2001 and involved an F-16 aircraft. These accident rates are not considered significant (AFFTC 1996).

Ground Test Activities

During laser ground test activities there would be a potential for direct laser-beam hazards to the eyes and skin as well as the potential for non-beam hazards.

For ground test scenarios, the direct laser-beam NOHDs for unrestricted lasing using systems such as the BILL, TILL, and HEL could be expected to extend far beyond the target (possibly greater than 6 miles) (AFCEE 2003). The NOHZ would be represented by a hemisphere or dome extending out into free space above the target area to an altitude equal to the appropriate NOHD and with the ground serving as the impermeable floor of the dome.

The potential non-beam hazards would include fire, shock or electrocution, collateral radiation, and LGACs.

The irradiance of objects from Class 4 lasers presents a fire hazard. However, since the target boards and rotoplanes would be constructed of flame retardant materials, as defined by the National Fire Protection Association, the potential for fires would further be reduced. Control measures would limit the potential for any resulting fires to the immediate target area, which is generally devoid of additional combustible materials (the surface area surrounding the targets would be graded to remove vegetation and make the target more visible during test missions).

The power sources used to create the laser beam could create a shock or electrocution hazard. Since qualified electricians and trained personnel would be working on these systems, the possibility of shock or electrocution would be extremely remote. Wiring and electrical support for ground test activities would be contained in the aircraft or other lasing platforms. For these reasons, electrical exposure to personnel other than those directly associated with the project should not create any significant impacts.

The potential for collateral radiation or black-body radiation (ultraviolet or blue light) produced as a result of air breakdown at the laser target interface would not present an immediate hazard to personnel. Since personnel would not be within the immediate lasing area and protective goggles would be worn by project personnel, no collateral radiation hazards should exist during laser ground test activities. Once lasing activities ceased, collateral radiation (if any) would cease, and no residual collateral radiation would remain (AFCEE 2003).

The quantity, composition, and chemical complexity of LGACs depend greatly on beam irradiance. When the target irradiance reaches a given threshold, approximately 10 MW/cm^2, target materials, including plastics, composites, and metals, may liberate toxic and noxious airborne contaminants. Air contaminants can be generated when certain Class 4 laser beams interact with matter (Laser Institute of America 2003). LGACs would not be created during low-power testing. Target boards would be equipped with infrared sensors used to detect the laser beam(s). Sensor data would be transmitted electronically to the test command and control center. Since LGACs would only be created during high-power lasing events, the command center could terminate the lasing activities if necessary to prevent human exposure. The Bioenvironmental Engineering office (95 AMDS/SGPB) would ensure the industrial hygiene characterizations of exposure to LGACs were used as required by 29 CFR Part 1900.1000, *Air Contaminants*, and AFOSH Standard 48-8, *Controlling Exposure to Hazardous Materials*; these measures would ensure no occupational overexposure to LGACs occurred. The controlled access to the remote target areas on-base would further reduce the potential for LGACs to create any significant impact.

4.12.3.2 Mitigation Measures

To minimize potential laser hazards, multiple controls will be used to reduce the potential for off-range lasing and accidental lasing of unsuspecting receptors. These controls will include:

- Use of backdrops and enclosures;
- Horizontal and vertical buffer zones;
- Administrative controls; and
- Removal of mirror-like reflecting surfaces from the test area.

Backdrops and Enclosures. Because these laser systems operate within the near- and far-infrared wavelengths of the electromagnetic spectrum, they are invisible to the unaided eye. Natural backdrops will provide a sufficient vertical boundary preventing anyone from directly viewing the beam or preventing viewing from off-base (AFCEE 2003). Backdrops will minimize the amount of reflection leaving the range. Catastrophic failure of the beam control system (system which points the laser beam at the target), although unlikely, represents a scenario in which the laser might circumvent backstops or enclosures resulting in off-target lasing. Safety interlocks associated with the laser systems will be in place to stop lasing activities if the beam control steers the beam from the projected path to the target. Figure 4-6 shows the typical backdrop and enclosure that could be used for G/G laser test and evaluation events.

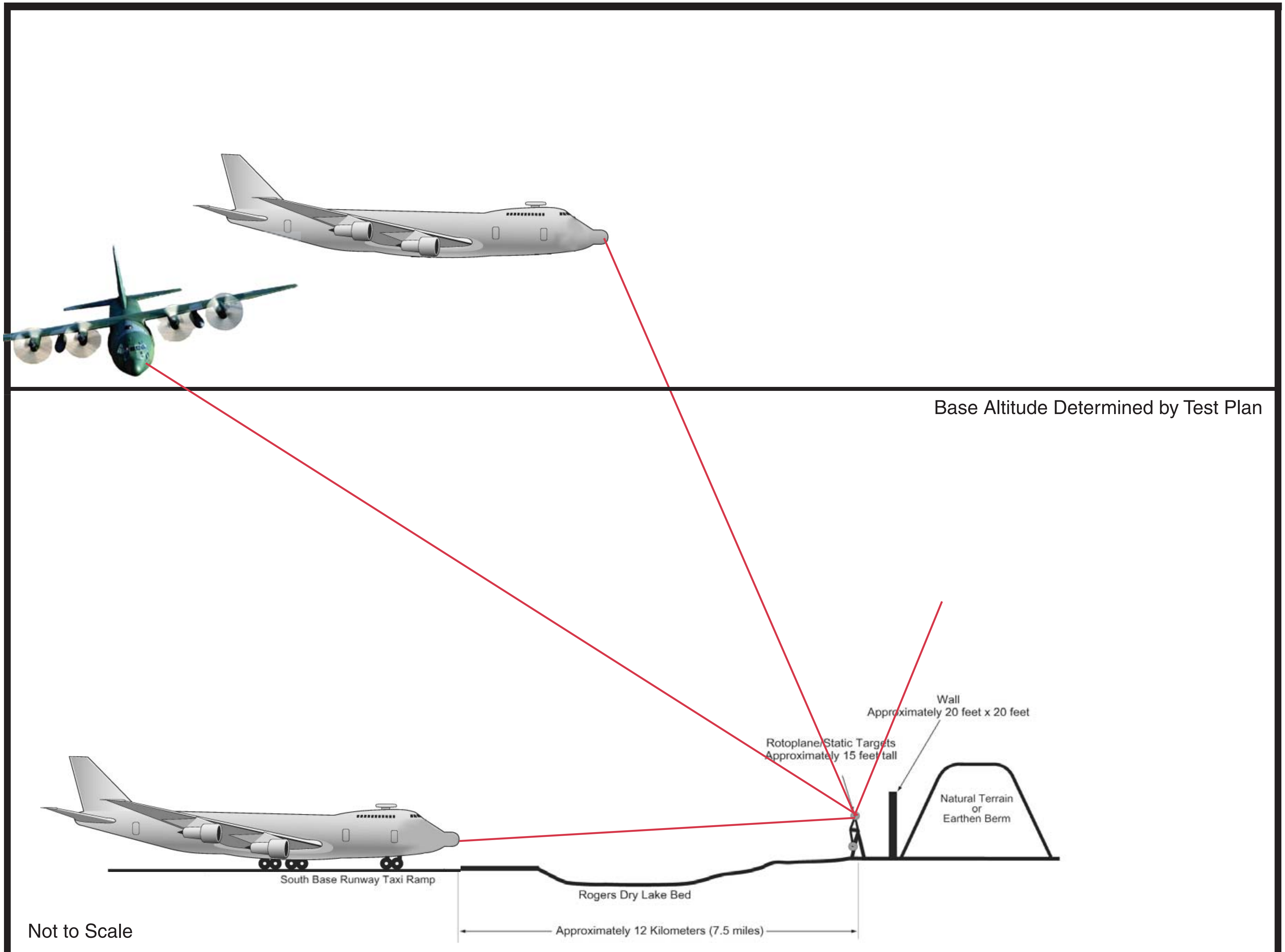
Horizontal and Vertical Buffer Zones. Per laser safety guidelines, horizontal and vertical buffer zones will be established for laser ground testing activities. Buffer zones provide a margin of safety regarding accidental beam shifting or unanticipated beam divergence. Horizontal and vertical buffer zones are determined for each laser and may be different for each laser. ANSI Z136.1, *Safe Use of Lasers Outdoors*, states the buffer zone is established as an angle that is five times the worst case pointing inaccuracy (ANSI 2000b). As an example of a possible buffer zone calculation, for typical ground test scenarios where targets are lased from the south ramp adjacent to the BFTF, the horizontal buffer zone will be approximately 44 feet (for a target that is 7 kilometers [~ 4 miles] from the lasing source) (Figure 4-7). Actual buffer zones will be computed during safety analysis for each laser operation.

Administrative Control. Access to the range and target areas during laser ground test activities will be restricted to authorized and properly trained personnel, thus reducing the possibility for ocular and skin exposure to laser radiation. Prior to outdoor laser test and evaluation activities, the range and target area will be physically checked to clear any unauthorized personnel from the area and ensure active nests are not on the target. Additionally, the area will be cleared of any mirror-like surfaces to minimize the direct reflections. Each laser system and test scenario will have specific procedures (approved by the range and laser safety office) to ensure operational safeguards and safety precautions are in place. Safety interlocks associated with the laser system will be in place to stop the lasing activity if the beam exits the anticipated beam path. Warning signs, as required by ANSI Standard Z136.1-2000 for Class 4 lasers, will be posted indicating the area is a laser-controlled area. Based on each test scenario, the test director will implement additional administrative controls similar to those adopted by the DoD and outlined in the ANSI Standard Z136.1, *Safe Use of Lasers Outdoors*. As cited by ANSI Standard Z136.1, an adequate hazard criterion for retinal exposures to non-visible lasers should equal 10 seconds. This will account for incidental viewing or purposeful staring at the beam. In this case, eye movements provide a natural exposure limitation eliminating the need for calculations based on exposure durations greater than 10 seconds (except for unusual viewing conditions) (ANSI 2000a).

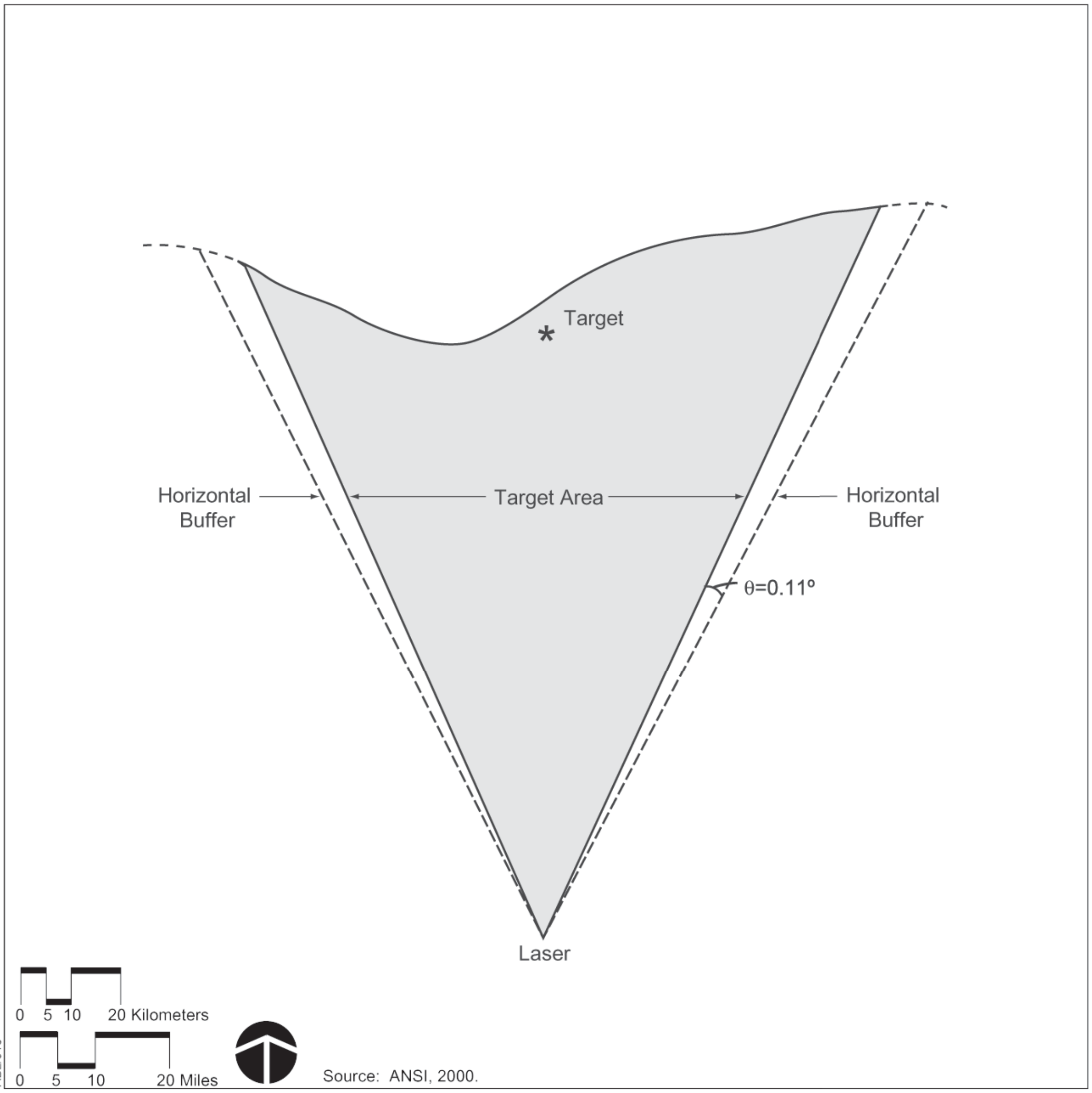
Prior to each laser test and evaluation event the Range Safety Office (412 TW/ENROR) will be required to complete a laser hazards evaluation. The Range Safety Office will use the LHAZ 3.0 program (or the most current Air Force laser hazard evaluation software) and record the information on an AF Form 2760, *Laser Hazard Evaluation*, or equivalent. The Chief of Range Safety is the approval authority for all laser related events on the PIRA. This approval is embedded as an integral part of the safety review process (AFFTC 2004). Subsequently, the probability of an environmental effect occurring that would impact safety if Alternative A were implemented would be less than significant; no mitigation would be required.

4.12.3.3 Safety and Occupational Health—Region 2

No direct or indirect impacts would be anticipated as a result of implementing Alternative A. Flight tests would be conducted at altitudes identified in the test and safety plans. For most A/A testing, lasers would be aimed from the laser test aircraft to target boards attached to the Proteus aircraft. These flight tests would be similar to other flights that occur every day over the R-2508 Complex. For laser testing in the G/A and A/G modes, the ground-based FPs and LTAs would be located on Edwards AFB. No G/G laser testing would be conducted in Region 2.



Typical Backdrops for A/G and G/G Laser Tests	Figure 4-6	Q242-03	1/06/05



Example of Horizontal Buffer Zone for Ground Target	Figure 4-7	Q242-03	1/06/05

Safety and occupational health impacts resulting from a crash of the laser test and evaluation aircraft or target aircraft would not be anticipated because the probability of a crash is low. The breakup of a plane during a crash and subsequent recovery activities could directly impact safety and occupational health if the crash occurred in a populated area; however, this would be the same as any other aircraft crashing in a populated area. In the event of an accident, Edwards AFB would be required to comply with established regulations and emergency response plans. Aircraft take-offs and landings would be restricted to Edwards AFB and would not occur at off-base facilities except during emergencies.

Impacts on safety and occupational health in Region 2 would be less than significant, and no mitigation would be required.

4.12.4 Alternative B (Limited Capability)

The safety and occupational health impacts created as a result of implementing Alternative B would be less than the potential impact created by Alternative A because only low power tests would occur outside of test facilities. The same number of flight tests and ground activities would occur under Alternative B as under Alternative A.

4.12.4.1 Safety and Occupational Health—Region 1

The AFFTC's Hazardous Communication Program and Institutional Safety and Occupational Health programs would be followed to reduce the potential for any risk to health and safety from laser test and evaluation activities. Under normal conditions, because construction of new facilities would not be required for the program, impacts on on-base safety and occupational health for non–project-related personnel would not occur.

Flight Test Activities

The primary hazard associated with flight test activities would be the laser energy reflected off the target; however, since the radiated energy outside the test facilities and controlled areas would be limited to low power (less than 10 watts), the potential for reflected energy to affect safety and occupational health would be significantly less than the potential impacts described in Alternative A. At Edwards AFB, A/A laser test and evaluation activities would use the Proteus aircraft with mounted target boards. Air-to-air laser engagements would occur at altitudes restricted based on the approved test plan, safety plan, and technical requirements. Specific altitude restrictions would be based on FAA requirements, particularly around airports and airfields that require laser hazard safety zones. Potential indirect safety and occupational health flight hazards would include fire, shock or electrocution, and collateral radiation. Laser-generated air contaminants would not be generated at low power levels.

The irradiance of objects from Class 4 lasers presents a fire hazard. For A/A laser test and evaluation activities, the target boards mounted on the Proteus aircraft would only be radiated at low power, minimizing the potential for fire. For A/G laser test and evaluation activities, the target boards and rotoplanes would be constructed of flame retardant materials, as defined by the National Fire Protection Association, thus reducing the potential for fires in the target area. Control measures would limit the potential for any resulting fires to the immediate target area, which is generally devoid of additional combustible materials (the surface area surrounding the targets would be graded to remove vegetation and make the target more visible during test missions).

The power sources used to create the laser beam could create a shock or electrocution hazard. Since qualified electricians and trained personnel would be working on these systems the possibility of shock or electrocution would be extremely remote. Wiring and electrical support for flight test activities would be contained in the aircraft. For these reasons, electrical exposure to personnel other than those directly associated with the project should not create any significant impacts.

The potential for collateral radiation or black-body radiation (ultraviolet or blue light) produced as a result of air breakdown at the laser target interface would not present an immediate hazard to personnel. Since personnel would not be within the immediate lasing area and protective goggles would be worn by flight crews and project personnel, no collateral radiation hazards should exist during laser ground test activities. Once lasing activities ceased, collateral radiation (if any) would cease, and no residual collateral radiation would remain (AFCEE 2003).

For A/G test scenarios, the direct laser-beam NOHDs for unrestricted lasing using systems such as the BILL, TILL, and HEL could be expected to extend far beyond the target (possibly greater than 6 miles) (AFCEE 2003). The NOHZ would be represented by a hemisphere or dome extending out into free space above the target area to an altitude equal to the appropriate NOHD and with the ground serving as the impermeable floor of the dome.

The Air Force considers BASH a safety concern for aircraft operations. The BASH hazards are managed to reduce the probability of a bird/aircraft impact. Most birds typically fly at altitudes below 2,500 feet AGL. Since most laser test and evaluation aircraft would be operating above 3,000 feet AGL except during takeoff and landing, the potential for impacts to laser test and evaluation aircraft would be the same as for other non-laser test and evaluation aircraft missions. Methods that have been used at Edwards AFB to control the bird air strike problem include the use of horned larks and use of a falconer. Therefore, the likelihood of a BASH incident is considered low.

In the event of an accident, AFFTC would be required to comply with Occupational Safety and Health and Administration regulations and AFFTC's Emergency Response Plan. The crash of test aircraft could cause casualties and loss of property. However, strict guidelines and flight procedures have shown the probability of such an occurrence is extremely low for this type of preplanned event. Historically, there is no information on mission-related aircraft accidents that may have taken place on Edwards AFB or in Region 1 or Region 2; however, an estimate of aircraft mishap rates in 1996 suggested that a Class A mishap (a mishap that resulted in at least a $1,000,000 loss or the loss of one life) would occur every 4.28 years. Test aircraft such as the F-15, F-16, and T-38 have annual Air Force–wide Class A mishap rates of 2.53, 4.5, and 1.58 per 100,000 flight hours, respectively. The last recorded Class A mishap at Edwards AFB was in 2001 involved an F-16 aircraft. These accident rates are not considered significant (AFFTC 1996).

Ground Test Activities

During laser ground test activities there would be a potential for direct laser-beam hazards to the eyes and skin as well as the potential for non-beam hazards. Only low power levels (less than 10 watts) would be used when lasing ground targets outside the test facilities (BFTF and SIL).

For ground test scenarios, the direct laser-beam NOHDs for unrestricted lasing using systems such as the BILL, TILL, and HEL could be expected to extend far beyond the target (possibly greater than 6 miles) (AFCEE 2003). The NOHZ would be represented by a hemisphere or dome extending out into free space above the target area to an altitude equal to the appropriate NOHD and with the ground serving as the impermeable floor of the dome.

The potential non-beam hazards would include fire, shock or electrocution, and collateral radiation.

The irradiance of objects from Class 4 lasers presents a fire hazard. However, since the target boards and rotoplanes would be constructed of flame retardant materials, as defined by the National Fire Protection Association, the potential for fires would be reduced further. Control measures would limit the potential for any resulting fires to the immediate target area, which is generally devoid of additional combustible materials (the surface area surrounding the targets would be graded to remove vegetation and make the target more visible during test missions).

The power sources used to create the laser beam could create a shock or electrocution hazard. Since qualified electricians and trained personnel would be working on these systems the possibility of shock or electrocution would be extremely remote. Wiring and electrical support for ground test activities would be contained in the aircraft or other lasing platforms. As such, electrical exposure to personnel other than those directly associated with the project should not create any significant impacts.

The potential for collateral radiation or black-body radiation (ultraviolet or blue light) produced as a result of air breakdown at the laser target interface does not present an immediate hazard to personnel. Since personnel would not be within the immediate lasing area and protective goggles would be worn by project personnel, no collateral radiation hazards should exist during laser ground test activities. Once lasing activities ceased, collateral radiation (if any) would cease, and no residual collateral radiation would remain (AFCEE 2003).

4.12.4.2 Mitigation Measures

To minimize potential laser hazards, multiple controls will be used to reduce the potential for off-range lasing and accidental lasing of unsuspecting receptors. As described in the mitigation measures for Alternative A, these controls will include:

- Use of backdrops and enclosures;
- Horizontal and vertical buffer zones;
- Administrative controls; and
- Removal of mirror-like reflecting surfaces from the test area.

Prior to each laser test and evaluation event, the Range Safety Office will be required to complete a laser hazards evaluation. The Range Safety Office will use the LHAZ 3.0 program (or the most current Air Force laser hazard evaluation software) and record the information on an AF Form 2760, *Laser Hazard Evaluation*, or equivalent. The Chief of Range Safety is the approval authority for all laser related events on the PIRA. This approval is embedded as an integral part of the safety review process (AFFTC 2004). Subsequently, the probability of an environmental effect occurring that would impact safety if Alternative B were implemented would be less than significant; no mitigation would be required.

4.12.4.3 Safety and Occupational Health—Region 2

The impacts on safety and occupational health from implementing Alternative B would be similar to those described for Alternative A. The same number of flight tests and ground activities would occur under Alternative B as with Alternative A. The potential safety and occupational health impacts from implementing Alternative B would be less than significant; therefore, no mitigation would be required.

4.12.5 Alternative C (No-Action Alternative)

Under the No-Action Alternative, no new laser test missions other than those previously approved under the Airborne Laser Program would occur (AFCEE 2003; U.S. Air Force 1997). Aircraft using the R-2508 Complex would continue to comply with approved flight profiles and missions per applicable DoD, Air Force, and AFFTC instructions. There would be no additional impacts on safety and occupational health resulting from the No-Action Alternative. No additional mitigation measures beyond those described in the ABL environmental impact statements would be required under if Alternative C were implemented.

4.13 SOCIOECONOMICS

Socioeconomic impacts would be considered significant if they substantially altered the location and distribution of the population within the ROI; caused the population to exceed historic growth rates; decreased jobs so as to substantially raise the regional unemployment rates or reduce income generation; substantially affected the local housing market and vacancy rates; or resulted in the need for new social services and support facilities.

4.13.1 Alternative A (Desired Capability, Proposed Action Alternative)

Implementation of the laser test and evaluation flight and ground testing under Alternative A would not create significant impacts to socioeconomics in the on- or off-base region. No mitigation would be required.

The small increase in the number of project personnel would have a positive impact on economic conditions in the area. Because test and evaluation programs at Edwards AFB change on a routine basis, the number of support personnel in the area remains somewhat constant. The on-base housing would be able to absorb increases in military personnel due to normal vacancies and the transitioning of other military personnel and programs to other locations. The vacancy rate for on-base housing remains stable at 10 percent (McCullough 2003). The added civilian/contractor and military personnel would have a short-term positive impact on the local economy of the Antelope Valley for the duration of the test and evaluation program. An increase in on- and off-base revenues would be expected to occur as a result of money spent for program materials, housing, and daily services. These increases would be a boost to the local economy. No new significant development for laser testing would be required under Alternative A, and current Air Force and contractor personnel from other bases would be used for the proposed laser testing program. Alternative A would not be expected to have an adverse impact on the on-base or off-base socioeconomics.

4.13.2 Alternative B (Limited Capability)

Implementation of the laser test and evaluation flight and ground testing under Alternative B would not create significant impacts to socioeconomics in the on- or off-base region. No mitigation would be required. The same number of flight and ground tests would occur under Alternative B as with Alternative A. Alternative B would not be expected to have an adverse impact on on-base or off-base socioeconomics.

4.13.3 Alternative C (No-Action Alternative)

Under the No-Action Alternative, no new laser test missions other than those previously approved under the Airborne Laser Program would occur (AFCEE 2003; U.S. Air Force 1997). Aircraft using the R-2508 Complex would continue to comply with approved flight profiles and missions per applicable DoD, Air Force, and AFFTC instructions. There would be no additional impacts on socioeconomics resulting from the No-Action Alternative. No additional mitigation measures beyond those described in the ABL environmental impact statements would be required if Alternative C were implemented.

4.13.4 Mitigation Measures

Since no significant impacts to socioeconomics would be anticipated under Alternative A, B, or C, no mitigation would be required.

4.14 WATER RESOURCES

A project would have a significant impact on water resources if it caused substantial flooding or erosion; substantially affected any significant water body, such as an ocean, stream, lake, or bay; exposed people to reasonably foreseeable hydrologic hazards such as flooding or tsunamis; or substantially affected surface or groundwater quality or quantity.

No adverse significant impacts on water resources would be expected from the proposed testing. There are no perennial streams on-base, and storm water runoff for the entire watershed is directed toward the three playa lakebeds: Rogers, Rosamond, and Buckhorn Dry Lakes. Use of the playa lakebeds would occur only when the water retained during the rainy season had evaporated. Ground-disturbing activities in the lakebed could occur with the establishment of LTAs, which would involve constructing earthern berms and limited, off-road vehicle traffic. The LTAs would be approved by 95 ABW/CEV Environmental Management. Ground targets would typically include target boards made of aluminum, titanium, wood, plastic, or steel.

The potential impact of laser testing on the playa lakebeds would be one of increased heat (refer to Section 4.5, Geology and Soils). The pulsing of laser beams to target boards would be over a short period (generally less than 10 seconds) (Leonard 1998). The diameter of the laser beam would be less than 18 inches.

Air quality impacts relative to water resources would be insignificant. Based on the conformity applicability screening analysis, air emissions created during flight and ground test activities would be less than significant (see Section 4.1). The lased target would not be expected to create significant air emissions. No adverse significant impacts on Region 1 water resources would be expected from hazardous materials and hazardous wastes (see Section 4.6). Impacts on on-base water resources from the result of a crash would not be anticipated because the probability of a crash would be low (Section 4.12). Take-offs and landings conducted from the Rogers Dry Lakebed would not be expected to affect the lakebed since landings and take-offs normally occur there when the lakebed is dry.

Test and evaluation programs would use existing facilities and modify buildings on an as-needed basis. Additional construction may be required to modify existing facilities and target sites to support the proposed programs. Any increases in storm water runoff resulting from increases in paved areas would be handled by the current storm water drainage system. Major modifications to existing buildings that would use water resources may require a separate environmental analysis; however, no major modification or construction is anticipated and no impact to water resources would be expected.

4.14.1 Alternative A (Desired Capability, Proposed Action Alternative)

For low, medium, and high power A/A and G/A lasing, targets would be located in restricted area R-2515 over Edwards AFB. In the A/A lasing mode, the laser test and evaluation aircraft would typically be above 3,000 feet AGL, at an altitude required by the test plan. Normally the target aircraft would be above the laser source; however, the geometry would be established so the laser beam and reflected energy remained within the range area. In the G/A lasing mode, the ground-based laser would be located on Edwards AFB and the laser would be fired at targets in restricted area R-2515 located over Edwards AFB. In the G/A mode, the geometry of the testing would preclude laser energy from reaching the earth's surface. In the A/G mode, the ground target would be restricted to Edwards AFB. The aircraft firing the laser toward the ground target could be at various locations within the R-2508 Complex. Due to the reflective properties of water, laser test and evaluation would not be directed at G/G targets across Rogers Dry Lakebed or at A/G targets when water was present.

4.14.1.1 Water Resources—Region 1

Flight Test Activities

For A/A lasing, targets would be located in the airspace over Edwards AFB or within restricted area R-2515 airspace. Aircraft firing toward the A/A target could be at other locations within the R-2508 Complex. There would be no impacts on Region 1 water resources from conducting A/A laser testing.

Target boards and other approved ground targets used for lasing in the A/G mode would be located on Edwards AFB. For A/G testing operations, areas of topographic relief would be utilized as backdrops for laser target boards during lasing events; target sites located near or on dry lakebeds would use earthern berms for backdrops. The backdrop would prevent errant laser beams from leaving the range when targets were lased. Due to the reflective properties of water, laser test and evaluation would not be directed at A/G targets across Rogers Dry Lakebed when water was present.

During G/A testing, lasing toward the air-based target would occur from an established FP on Edwards AFB to the target within varying locations in the R-2508 Complex. The FP location would be previously approved by 95 ABW/CEV Environmental Management. In the G/A mode, the geometry of the testing would preclude laser energy from reaching the earth's surface. No impacts on water resources from G/A lasing would be anticipated.

Ground Test Activities

During G/G testing, beams from lasers would be directed over open land to ground targets with backdrops on Edwards AFB. The pulsing of the laser beam to target boards would be over a short period, usually less than 10 seconds, and the diameter of the laser beam would be less than 18 inches. Setting target boards above the lakebed soils is preferred in order to minimize the potential for secondary soil reflection and reflection off spectral surfaces. Reflective properties are based on factors such as mineral and moisture content, and the angle of incidence of the laser beam. Open range ground testing of unshrouded laser systems would not be conducted if water was present in the adjacent dry lakebeds, due to reflective surface concerns.

Communications Laser Tests

The testing of communications laser systems would not create significant impacts on water resources. These tests would be similar to the flight and ground tests noted above; however, due to the reduced power levels (0.01 to 200 W/cm^3) used by free space optical systems, the potential for any impact would be less. There would be no impacts on water resources during A/S and S/A testing modes since the laser energy generated during these modes of operation would not reach the earth's surface.

4.14.1.2 Water Resources—Region 2

All ground targets and FPs for the proposed A/G and G/A modes under Alternative A laser test and evaluation activities would be located on-Base; therefore, no impacts to off-Base water resources would occur during the A/G and G/A testing modes. No G/G testing would be conducted off-Base.

4.14.1.3 Mitigation Measures

All earthwork conducted in the playa lakebeds will be planned and conducted when the lakebed is dry. If suggested mitigation measures for geology and soils (Section 4.5) are followed, then no additional mitigation measures for water resources will be required.

4.14.2 Alternative B (Limited Capability)

4.14.2.1 Water Resources—Region 1

Flight Test Activities

For A/A low power lasing, targets would be located in the airspace over Edwards AFB or within restricted area R-2515 airspace. Aircraft firing toward the A/A target could be at other locations within the R-2508 Complex. There would be no impacts on Region 1 water resources from conducting low power A/A testing.

For A/G testing operations, areas of topographic relief and earthern berms would be utilized as backdrops for laser target boards during lasing events. Target boards and other approved ground targets used for A/G mode would be located on Edwards AFB. The backdrop would prevent errant laser beams from leaving the range when targets were lased. Aircraft would fire the laser toward A/G targets from various locations within the R-2508 Complex. The pulsing of laser beams to target boards would be over a short period, usually less than 10 seconds. The diameter of the laser beam would be less than 18 inches.

During G/A testing, low power lasing toward the air-based target would occur from an established FP on Edwards AFB to the target within varying locations in the R-2508 Complex. Lakebed soils would potentially be disturbed from target positioning or target construction, however, the LTA would have approval from 95 ABW/CEV Environmental Management. There would be no anticipated impacts on water resources from G/A lasing.

Ground Test Activities

During G/G testing, beams from low power lasers would be directed over open land to ground targets with backdrops on Edwards AFB. Setting target boards above the soil surface is preferred in order to minimize the potential for secondary soil reflection and reflection off spectral surfaces. Reflective properties are based on factors such as mineral and moisture content and the angle of incidence of the laser beam. Due to reflective surface concerns, open range ground testing of unshrouded laser systems would not be conducted if water was present in the adjacent dry lakebeds.

Communications Laser Tests

There would be no impacts on water resources during A/S, G/S, S/A, or S/A testing modes since the laser energy generated during these modes of operation would either not reach the earth's surface or be at such a low power that it would not cause any changes to the water resources.

4.14.2.2 Water Resources—Region 2

Flight Test Activities

For A/A low power lasing, targets would only be located in restricted area R-2515 over Edwards AFB or within the R-2515 airspace. Aircraft firing toward the A/A target could be at other locations within the

R-2508 Complex. Since there would be no targets in the portions of Region 2 outside of Region 1, the potential for impacts to water resources in Region 2 in negligible. Also, since the test conducted under Alternative B would only use low power lasers, and the low power levels would be lower in wattage than the average household light bulb, no impacts would be expected.

Ground Test Activities

All ground targets and FPs for the proposed A/G and G/A modes under Alternative B laser test and evaluation activities would be located in Region 1; therefore, no impacts to Region 2 water resources outside of Region 1 would occur during the A/G and G/A testing modes. No G/G testing would be conducted in the portions of Region 2 that lie outside of Region 1.

Communications Laser Tests

There would be no impacts on water resources during A/S, G/S, S/A, or S/A testing modes since communication laser testing would not occur in those portions of Region 2 that are outside of Region 1.

4.14.2.3 Mitigation Measures

Mitigation measures would be the same as those for Alternative A.

4.14.3 Alternative C (No-Action Alternative)

Under the No-Action Alternative, no new laser test missions other than those previously approved under the Airborne Laser Program would occur (AFCEE 2003; U.S. Air Force 1997). Aircraft using the R-2508 Complex would continue to comply with approved flight profiles and missions under applicable DoD, Air Force, and AFFTC instructions. There would be no additional impacts on water resources resulting from implementing the No-Action Alternative. There would be no additional impacts on water resources resulting from flight tests of the ABL in the A/A modes. Low power lasing of G/G targets would be limited to the PIRA, and potential impacts would be similar to those described for ground test activities under Alternative B. No additional mitigation measures beyond those described in the ABL environmental impact statements would be required under if Alternative C were implemented.

4.15 CUMULATIVE IMPACTS

The CEQ regulations define "cumulative impact" as the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The ROI for cumulative impact analysis includes Edwards AFB. The only areas with potential cumulative impacts would be air quality, land use, and noise.

4.15.1 Past, Present, and Future Operations

Since 2000, the level of flight activity at AFFTC and Edwards AFB has remained fairly constant. Typically, when one flight test program is completed a new flight test program begins. The number of personnel, vehicles, aircraft, and basic infrastructure needed to support these flight activities is proportionate to the number of sorties flown. The numbers of sorties associated with operations at Edwards AFB (including NASA-related flights) from 2000 through 2004 have been approximately 10,500 per year (AFFTC 2005). The number of sorties has varied from a 7.5 percent decrease from 2000 to 2001 to a 2.7 percent increase from 2002 to 2003 and 9 percent decrease from 2003 to 2004. Table 4-8 shows the aircraft type and sorties for those years. These aircraft regularly use the runways, restricted area R-2515, low-level routes, supersonic corridors, and targets on the PIRA for testing aircraft integration and system capabilities. Overall, flight test operations at Edwards AFB have been analyzed in the *EA for Continued Use of R-2515* (Edwards AFB 1998). The proposed action in that document included the operations summarized in Table 4-8; it was concluded that these operations would result in no significant cumulative impacts.

Table 4-8

Sortie Summary by Aircraft and Year at AFFTC

	Year				
Aircraft Type	**2000**	**2001**	**2002**	**2003**	**2004**
B-1	110	118	135	81	74
B-2	15	44	9	47	36
B-52	47	69	61	70	66
BE-20	0	3	53	28	5
BE-200	50	66	75	49	44
Boeing 737/747/757	14	12	14	46	13
C-5	0	0	3	34	67
C-12	451	483	494	600	602
C-130	106	163	92	84	145
C/KC-135	674	653	784	837	709
C-17	194	139	223	194	221

Table 4-8, Page 1 of 2

Table 4-8

Sortie Summary by Aircraft and Year at AFFTC (Continued)

Aircraft Type	Year 2000	2001	2002	2003	2004
CH-46	275	266	326	346	76
CH-53	133	227	319	220	62
DC-8	12	19	44	34	16
ER-2	74	95	78	34	19
F-117	391	312	337	274	342
F-15	1,088	920	843	820	596
F-16	3,128	2,706	2,782	3,035	2,978
F-18	624	479	463	349	271
F-22	154	337	565	909	1,021
HH-60G	0	16	80	111	140
KC-10	24	55	65	67	180
T/AT-38	2,773	2,315	1,926	1,894	1,545
X-45	0	0	7	10	27
Other	915	910	672	522	474
Totals	11,252	10,407	10,450	10,695	9,729

Table 4-8, Page 2 of 2
Source: Air Force Flight Test Center 2005

Considering the 60 to 170 missions as an addition to existing operations is probably the worst case assumption. The evaluations completed for the overall flight test activity at Edwards AFB cited above were done with consideration for the normal and continuous initiation and completion of flight test programs. The laser test and evaluation missions as addressed in this EA in all probability would not be additive to actions already analyzed, but rather would replace flight test programs recently completed. However, given the extensive flight operations at Edwards AFB, the addition of up to 170 missions per year for each of two aircraft is an increase of less than 3.4 percent. In general, since the operations (airspeeds, altitudes, aircraft type) of these missions would be similar to those already evaluated, it would be expected these missions would have no measurable cumulative impact on most of the existing environment.

Current programs recently evaluated and found to have no significant impact are described in the following documents:

- *EIS for the Program Definition and Risk Reduction Phase of the Airborne Laser Program* (U.S. Air Force 1997);

- *EA for the Orbital Reentry Corridor for Generic Unmanned Lifting Entry Vehicle (LEV) Landing at Edwards AFB* (AFFTC 2002); and

- *EA Armed Munition Integration Testing on the PIRA* (AFFTC 2005).

Collectively the sorties for these three programs (ABL, LEV, and Armed Munitions Integration Testing on the PIRA) and this program could add up to 174 sorties annually (Table 4-9), a less than 2 percent increase in activity. Adding the projected sorties for the laser test and evaluation flights would increase sorties up to an additional 4 percent (in 2008 if all projected sorties for these programs are flown), which is well within the support capacity of Edwards AFB and the AFFTC. The total sorties for the chase and support aircraft would be expected to be routine flights included as part of the normal operational commitment and therefore would not create any additional cumulative impacts.

Table 4-9

Projected Sorties for New Programs

Year	Airborne Laser	Lifting Entry Vehicles	Armed Munitions Integration Testing	Test and Evaluation of Directed Energy Systems Using Laser Technology[1]
2006	72	2	100	120
2007	72	5	100	140
2008	69	5	100	280
2009	0	0	100	338
2010	0	0	100	340

Note: 1 – These totals include chase aircraft.

Sources: Air Force Flight Test Center 2002; Mattson 2005; Reinke 2005; Wilson 2004

These projects are all flight-related and have been identified individually as resulting in no significant impacts to the environment. Like this EA, each program deals with airspace, noise, and land use concerns that also result in minimal individual impacts. Detailed information and analysis of these projects is available on the World Wide Web at http//:www.ealev.com and http://www.boeing.com/defense-space/military/abl/flash.html.

Other future programs being evaluated include the next phase of the F-35 flight test program, the Unmanned Aerial Vehicle Flight Operations at Edwards AFB, and High Power Microwave testing program. Cumulative impacts of these programs will be addressed in separate EAs.

4.15.2 Areas with Potential Cumulative Impacts

This section addresses the potential additive effects of implementing the Proposed Action Alternative in combination with projects identified in Section 14.5. No significant impacts have been identified for the Proposed Action Alternative or the other alternatives presented in this EA. Conducting laser test and evaluation missions could result in cumulative impacts in the following areas.

4.15.2.1 Air Quality

The projects identified in Section 14.5 would be implemented during the same time frame as this action. They are not expected to have any significant cumulative air quality impacts. Air quality impacts from these projects would not individually result in any significant, long-term impacts although they may result in localized impacts of short duration. Since these projects are primarily aircraft-related, the air quality impacts would occur as a result of aircraft launch and recovery operations and while the aircraft are operating below 3,000 feet AGL. However, these air emissions, when combined, are still below the *de minimis* thresholds for criteria pollutants.

4.15.2.2 Land Use

The impacts associated with this Proposed Action would occur within the base boundary of Edwards AFB; therefore, only cumulative effects occurring on Edwards AFB will be addressed. The land area is on a designated Air Force range and is used primarily for bombing, laser targeting, and aircraft integration test activities. Past military test and evaluation activities do not present any further or additional environmental impacts when combined with this Proposed Action. Low power laser testing has routinely occurred on targets on the West Range and East Range, and within the facilities at the BFTF. Range management activities include routine inspection and cleanup of all range target sites. The cleanup of the laser ground target sites will continue as range personnel maintain due diligence and maintenance activities, thus minimizing the opportunity for any environmental impacts. Any newly designated laser targets or controlled areas would be fully investigated with hazard assessments completed prior to a change in land use. Minor impacts on the land use would result during the short period of the actual test (i.e., horizontal and vertical buffer zones might prevent access to other target sites; however this is typical for land use on a test range).

4.15.2.3 Noise

Several sources of noise were evaluated to determine if, when considered comprehensively, they would result in a cumulative noise impacts. These include aircraft, transportation, construction, and detonation-related noise. The noise impacts of the detonations and sonic booms can result in a similar response. Both are measured in pounds per square foot and are impulsive. As such, these impacts are considered together.

The AFFTC aircraft that generate sonic booms under existing operations are the F-15, F-16, and F-22; sonic booms are generated during high-speed (Mach 1.0 to 1.5) flights (AFFTC 2001). Sonic boom experiments carried out in the R-2508 Complex, using the SR-71, were completed in 1995. The measurements show that at high altitudes (approximately 65,000 to 80,000 feet AGL), high-speed sonic boom overpressures propagated by the SR-71 are less than 1.0 pounds per square foot at ground level. These experimental results generally fit into the established pattern of other available sonic boom data. In the *EA to Extend the Supersonic Speed Waiver for Continued Operations in the Black Mountain Supersonic Corridor and Alpha Corridor/Precision Impact Range* (AFFTC 2001) it was estimated that just over 600 supersonic flights were conducted through this area annually (averaged from 1980 through 1999). From 1997 through April 2000, only 56 noise complaints were received from persons within 50 miles of the corridors. Use of the local supersonic corridor by these aircraft does create additional noise impacts; however, analysis has shown these noise levels do not create a significant adverse impact (Edwards AFB 2002). The addition of up to 100 events resulting from detonations would also create additional noise impacts; however, based on past experience this would not create a significant adverse impact.

The noise created from other Region 2 transportation sources is expected to increase as a result of an increase in area population. The programs (ABL, LEV, Armed Munitions Integration and Testing) would use existing vehicles and equipment. Noise created from these sources would not increase the on-base noise contours. Because construction activities are not anticipated in support of these new programs, additional construction-related noise would not result in a cumulative environmental impact.

The addition of noise generated from up to 170 flight missions and 24 ground missions per year would add to the noise in the region of interest; however, this increase would add to the noise in the on-base ROI only for very brief periods of time and would be less than significant. Noise contour values resulting from these flights would be lower than ambient noise created from other civilian noise sources. Therefore, less than significant cumulative noise impacts would be anticipated under the test and evaluation of directed energy systems used in the laser technology program.

4.16 UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse impacts include those that are negative, occurring regardless of any identified minimization measures.

4.16.1 Ecological Resources

The Proposed Action would likely prevent the re-growth of small areas of terrestrial plant communities and reintroduction of any wildlife habitat at the laser target sites. The land routinely graded for this project was previously disturbed, so the plant communities are of marginal quality for wildlife.

4.16.2 Land Use

Under the Proposed Action, land use designations would not change.

4.17 SHORT-TERM VERSUS LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

Examples of short-term uses of the environment include direct, construction-related disturbances and direct impacts associated with an increase in population and activity that occurs over a period typically less than 5 years. Long-term uses of the environment include impacts occurring over a period of more than 5 years, including permanent resource loss.

Since no new development would be required under the test and evaluation of directed energy systems under the laser technology program, and current Air Force or contractor personnel from other bases would be used for the program, neither Alternative A, B, or C would involve any short- or long-term changes in population or productivity of the environment.

4.18 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irreversible and irretrievable resource commitments are related to the use of nonrenewable natural resources and the effects that the use of those resources will have on future generations. Irreversible effects primarily result from the use or destruction of a specific resource (e.g., energy and minerals) that cannot be replaced within a reasonable time frame. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of implementing an action (e.g., extinction of a rare or threatened species, or the disturbance of an important cultural resource site). In accordance with NEPA (40 CFR 1502.16), this section includes a discussion of any irreversible and irretrievable commitment of resources associated with the proposed project.

This programmatic EA only addresses the launch, flight operations, and lasing of controlled targets over Edwards AFB. Implementing any of these proposed actions would not require an irreversible or irretrievable commitment of resources. Irreversible or irretrievable commitment of resources that would be involved in other phases of the program (e.g., laser development, laser construction, or transportation to Edwards AFB) would be addressed in separate environmental documentation. Implementation of Alternative C (No-Action Alternative) would also not require an irreversible or irretrievable commitment of resources.

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5.0 REFERENCES

95th Air Base Wing (95ABW) and Air Force Flight Test Center (AFFTC)

2005 *R-2508 Complex Environmental Baseline Study, Edwards Air Force Base, California.* Document on file at 95 ABW/CEV technical library, Edwards AFB, CA. December.

Air Force Association Magazine

2004 A Plague of Accidents. *Journal of the Air Force Association*. Volume 87, No. 2. Accessed online at http://www.afa.org/.

Air Force Center for Environmental Excellence (AFCEE)

2003 *Final Supplemental Environmental Impact Statement for the Airborne Laser Program*. Document on file at www.afcee.brooks.af.mil/ ec/eiap/eis/abl/ABL_F-SEIS_Apr_03.pdf.

Air Force Flight Test Center (AFFTC)

1992 *Study of Freshwater Shrimp at Edwards Air Force Base, California*. Document on file at 95 ABW/CEV technical library, Edwards AFB, CA. December.

Air Force Flight Test Center (AFFTC)

1993 *Edwards Air Force Base Flood Study*. Document on file at 95 ABW/CEV technical library, Edwards AFB, CA. December.

Air Force Flight Test Center (AFFTC)

1994 *Edwards Air Force Base Comprehensive Plan*. Document on file at 95 ABW/CEV technical library, Edwards AFB, CA. June.

Air Force Flight Test Center (AFFTC)

1995 *Edwards Air Force Base Energy Plan*. Document on file at 95 ABW/CEV technical library, Edwards AFB, CA. March.

Air Force Flight Test Center (AFFTC)

1996 *Final Environmental Assessment for the Continued Use of the Precision Impact Range Area (PIRA), Edwards Air Force Base, California*. Document on file at 95 ABW/CEV technical library, Edwards AFB, CA. February.

Air Force Flight Test Center (AFFTC)

1997a *Edwards Air Force Base Utility System Study.* Document on file at 95 ABW/CEV technical library, Edwards AFB, CA. July.

Air Force Flight Test Center (AFFTC)

1997b *Edwards Air Force Base Comprehensive Plan,* Chapter 20, *Design Standards,* published under separate cover. Document on file at 95 ABW/CEV technical library, Edwards AFB, CA. March.

Air Force Flight Test Center (AFFTC)

1997c *Programmatic Environmental Assessment for the Basewide Removal, Replacement, and Installation of Oil/Water Separators, Edwards Air Force Base, California*. Document on file at 95 ABW/CEV technical library, Edwards AFB, CA. January.

Air Force Flight Test Center (AFFTC)

1997d *Programmatic Environmental Assessment for Routine Flightline Activities, Edwards Air Force Base, California*. Document on file at 95 ABW/CEV technical library, Edwards AFB, CA. March.

Air Force Flight Test Center (AFFTC)

1998a *Edwards Air Force Hazardous Waste Management Plan.* Document on file at 95 ABW/CEV technical library, Edwards AFB, CA. June.

Air Force Flight Test Center (AFFTC)

1998b *Stormwater Pollution Prevention Plan (SWPPP), Edwards Air Force Base, California*. Document on file at 95 ABW/CEV technical library, Edwards AFB, CA.

Air Force Flight Test Center (AFFTC)

1999 *Environmental Assessment of the Water Pipeline to the Air Force Research Laboratory Edwards Air Force Base, California*. Document on file at 95 ABW/CEV technical library, Edwards AFB, CA. February.

Air Force Flight Test Center (AFFTC)

2000 Draft *Model Environmental Assessment.* Document on file at 95 ABW/CEV technical library. March.

Air Force Flight Test Center (AFFTC)

2001 *Environmental Assessment to Extend the Supersonic Speed Waiver for Continued Operations in the Black Mountain Supersonic Corridor and Alpha Corridor/Precision Impact Range Area.* Document on file at 95 ABW/CEV technical library, Edwards, AFB, CA. April.

Air Force Flight Test Center (AFFTC)

2002 *Environmental Assessment for the Orbital Reentry Corridor for Generic Unmanned Lifting Entry Vehicle Landing at Edwards AFB*. Document on file at 95 ABW/CEV technical library. December.

Air Force Flight Test Center (AFFTC)

2003 *Semiannual Mobile Source Air Emissions Inventory for Edwards Air Force Base*. July and December.

Air Force Flight Test Center

2004 "R-2508 Complex," Edwards AFB, CA. http://r2508.edwards.af.mil/. Accessed December 16.

Air Force Flight Test Center

2005 Air Force Flight Test Center AFTO 781 Database-Annual Sorties Flown. August.

Air Force Institute for Environment, Safety and Occupational Health Risk Analysis (AFIERA)

2002 *Aircraft Engine Emissions Estimator*.

Albuquerque Tribune

2003 "Zap! Air Force Eyes 'Jedi' style Weapons" in the *Albuquerque Tribune Online*. Accessed at http://web.abqtrib.com

Alfred Gobar Associates

1997 *Antelope Valley Labor Market Study*. Prepared for Lancaster Economic Development Corporation. October.

American Association of Petroleum Geologists

2005 Home Page. http://www.aapg.org.

American National Standards Institute

2000a American National Standard for Safe Use of Lasers Outdoors, Z 136.1, August.

American National Standards Institute

2000b American National Standard for Safe Use of Lasers Outdoors, Z 136.6, August.

Bedke, Curtis

2005 Mission Statement for Air Force Flight Test Center by Brigadier General Bedke, U.S. Air Force, AFFTC Commander, Microsoft PowerPoint presentation on file at 95 ABW/CEVX office.

Busby, Colin I., John M. Findlay, and James C. Bard

1979 *A Cultural Resource Overview of the Bureau of Land Management Coleville, Bodie, Benton and Owens Valley Planning Units, California*. Basin Research Associates, Bakersfield, California.

California Air Resources Board (CARB)

2003a “Ambient Air Quality Standards” available at http://www.arb.ca.gov/aqs/aaqs2.pdf. July 9. (Accessed January 18, 2005).

California Air Resources Board (CARB)

2003b “State Area Designations” available at http://www.arb.ca.gov/desig/adm/adm.htm. December 5. (Accessed January 18, 2005).

California Environmental Protection Agency (Cal/EPA)

2001 “California Almanac of Emissions and Air Quality” website at http://www.arb.ca.gov/ aqd/ almanac/ almanac01/ almanac01.htm. (Accessed January 18, 2005).

Colorado Department of Transportation

2004 “Colorado DOT Tire/Pavement Noise Study”. Report No. CDOT-DTD-R-2004-5 Accessed online at http://tools.ecn.purdue.edu/~sqdh/noiselit.pdf.

Committee on Hearing, Bioacoustics and Biomechanics, Assembly of Behavioral and Social Sciences (CHABA)

1981 *Assessment of Community Noise Response to High-Energy Impulsive Sounds*. National Research Council, National Academy of Sciences, Washington, D.C.

Crosby

2005 Update of recorded cultural resource sites at Edwards AFB. June.

Cultural Systems Research, Inc.

1987 *California Low-Level Radioactive Waste Disposal Project: Cultural Resources Surveying: Ethnographic Resources Candidate Site Selection Phase*. Menlo Park, California.

Department of Defense (DoD)

2003 Joint Pub 1-02, DoD Dictionary of Military and Associated Terms. http://www.dtic.mil/doctrine/jel/doddict/index.html. Accessed February 2005.

Department of Energy (DOE)

2001 Department of Energy Home Page. http://www.eia.doe.gov. Accessed December 2004.

Directed Energy Professional Society

2003 *High Energy Laser Weapons Short Course*. Albuquerque, New Mexico. August.

Dutcher, L.C., and G.F. Worts, Jr.

1963 *Geology, Hydrology, and Water Supply of Edwards Air Force Base, Kern County, California: Sacramento, California.* U.S. Geological Survey Open-File Report.

Earle, D.D., B. Boyer, R.A. Bryson, R.U. Bryson, M.M. Campbell, J.J. Johannesmeyer, K.A. Lark, C.J. Parker, M.D. Pittman, L.M. Ramirez, M.R. Ronning, and J. Underwood

1997 *Cultural Resources Overview and Management Plan for Edwards AFB, California*. Volume 1, *Overview of Prehistoric Cultural Resources*. Computer Sciences Corporation, Edwards Air Force Base, California. Submitted to AFFTC, Base Historic Preservation Office, Edwards Air Force Base, California.

Earle, D. D., K. A. Lark, C. J. Parker, M. R. Ronning, and J. Underwood

1998 Cultural Resources Overview and Management Plan for Edwards AFB, California, Volume 2: *Overview of Historic Cultural Resources*. Computer Sciences Corporation, Edwards Air Force Base, California. Submitted to AFFTC, Base Historic Preservation Office, Edwards Air Force Base, California.

Edwards Air Force Base (Edwards AFB)

1996 *Edwards Air Force Base Joint Land Use Study*. Document on file at 95ABW/CEV technical library.

Edwards Air Force Base (Edwards AFB)

1998 *Environmental Assessment for Continued Use of R-2515 Restricted Area*. Document on file at 95 ABW/CEV technical library.

Edwards Air Force Base (Edwards AFB)

2002 *Draft Integrated Natural Resources Management Plan*. Document on file at 95 ABW/CEV technical library. October.

Edwards Air Force Base (Edwards AFB)

2004 *Final Integrated Natural Resources Management Plan*. Document on file at 95 ABW/CEV technical library. September.

Edwards Air Force Base (Edwards AFB)

2005 *R-2508 Users Guide*. http://r2508.edwards.af.mil.

Federal Aviation Administration (FAA)

2004 *FAA – Aeronautical Information Manual. Official Guide to Basic Flight Information and ATC Procedures*. Effective August 5, 2004.

Federal Interagency Committee on Noise

1992 *Federal Agency Review of Selected Airport Noise Analysis Issues*. August.

Federal Interagency Committee on Urban Noise (FICUN)

1980 *Guidelines for Considering Noise in Land-Use Planning and Control*. June.

Federal Register

2004 *Approval and Promulgation of Implementation Plans, Finding of Attainment, and Designation of Areas for Air Quality Planning Purposes; 1-Hour Ozone Standard, East Kern County, CA*. Volume 69, No. 78, Rules and Regulations. April 22.

Greene, Julie and Sanders, Andrew C.

N.D. Alkali Mariposa Lily. Herbarium Department of Botany and Plant Sciences, University of California, Riverside, California.

Haber, Jerold M. and Larson W.F.

2006 *Rapid Risk Analysis for High Energy Lasers and Illuminating the Risks from High Energy Lasers with GIS*. ACTA Inc., Torrance, CA

Hagenauer, Larry

2005 Personal communications. Tybrin Corporation. January/May/June.

Hecht, Jeff

2003 "Solid State High-Energy Laser Weapons". Optics & Photonics News, Optical Society of America. Pages 42–47. January. Online at http://www.osa-opn.org/.

Hickman, James C.

1993 *The Jepson Manual: Higher Plants of California*. University of California Press. Berkeley, California.

Illman, P.E.

1993 *The Pilot's Air Traffic Control Handbook*, 2nd Edition. TAB books, New York.

Keppler, Kenneth

2002 Personal communication regarding laser backscatter from ABL test activities. June.

Killinger, Dennis

2002 Free Space Optics for Laser Communications through the Air. *Optics and Photonics News*, October. Online at http://www.osa-opn.org/abstract.cfm?URI=OPN-13-10-36.

Laser Institute of America

2003 Target Laser-Generated Contaminants. Published in Laser Institute of America, Laser Safety News. Accessed at http://laserinstitute.org/publications/lia_today/archive/articles/Dealingw_LGACs/index2.php3.

Leonard, Steven G.

1998 *Laser Options for National Missile Defense.* Air Command and Staff College Air University, Maxwell Air Force Base, Alabama. April.

Levell, Peggy

1999 Electronic communication with Jocelyn Swain (Computer Sciences Corporation) regarding the amount of money Edwards AFB spent on education in fiscal year 1998. August 25.

Lexington Institute

2003 Directed Energy Weapons, Technologies, Applications, and Implications. Arlington, Virginia.

Lucas, M.J., and P.T. Calamia

1996 *Military Operations Area and Range Noise Model: NRNMAP User's Manual*. Final. Wright-Patterson AFB, Ohio: AAMRL. A1/OE-MN-1996-0001.

MARCOA Publishing, Inc.

1998 *Into the Future Edwards Air Force Base.* Document on file at Environmental Management AFFTC/EM, Edwards AFB, CA.

Mattson, Paul

2005 Personal communications regarding flight requirements for the Airborne Laser Program.

McCullough, Irmina

2003 Personal communication with Allen Tamura (Jt3/CH2MHill) regarding military family housing vacancy rates. February 27.

Montoya, Kevin

2005 Personal communication with Director of Directed Energy Programs at Edwards AFB. January/March/May/July.

Muroc Unified School District

2004 Personal communication between Tetra Tech, Inc. and Student Services. March.

National Aeronautical Charting Office (NACO)

2004a *H-3/H-4 IFR Enroute High Altitude—U.S.*, Washington, D.C.: National Aeronautical Charting Office, Federal Aviation Administration, U.S. Department of Transportation. April 15.

National Aeronautical Charting Office (NACO)

2004b *IFR/VFR Low Altitude Planning Chart.* Washington, D.C.: National Aeronautical Charting Office, Federal Aviation Administration, U.S. Department of Transportation. April 15.

National Aeronautical Charting Office (NACO)

2004c *L-3/L-4 IFR En Route Low Altitude –U.S.* Washington, D.C.: National Aeronautical Charting Office, Federal Aviation Administration, U.S. Department of Transportation. April 15.

National Aeronautics and Space Administration (NASA)

1997a *Environmental Assessment of Aircraft Consolidation at NASA at Dryden Flight Research Center* (DFRC). Department of the Air Force, Edwards, CA.

National Aeronautics and Space Administration (NASA)

1997b *X-33 Advanced Technology Demonstrator Vehicle Program Draft Environmental Impact Statement.* George C. Marshall Space Flight Center, AL. June.

National Aeronautics and Space Administration (NASA)

1999 *Annual Progress Report – Objective 9 Low-Cost Space Access –Create a Highway to Space.* http://aeronautics.nasa.gov/library/da/ar99/9-1v.html. Accessed December 2004.

National Parks Conservation Association

2005 Article on Hazy Days. http://www.npca.org/across_the_nation/ visitor_experience/clear_air/haze.asp. Accessed May 2005.

National Geospatial-Intelligence Agency

2004 *DOD Area Planning AP/IB Chart, Military Training Routes—Western U.S.*, St. Louis, MO: National Imagery and Mapping Agency. April 15.

National Oceanic and Atmospheric Administration

2001 U.S. Department of Commerce, Western Regional Climate Center website at http://www.wrcc.dri.edu (Accessed January 18, 2005).

National Park Service

2004 U.S. Department of Interior, National Park Service Web Site, http://www.nps.gov/.rivers/ (accessed March 2004).

Naval Air Weapons Station and Bureau of Land Management

2002 *Draft Environmental Impact Statement for Proposed Military Operational Increases and Implementation of Associated Comprehensive Land Use and Integrated Natural Resources Management Plans*. November.

Nonlethal Environmental Evaluation and Remediation Center

2003 Limited *Life Cycle Environmental Assessment for Advanced Tactical Laser (ATL).* Kansas State University, Manhattan, Kansas. June.

Norris, R.M., and R. W. Webb

1990 *Geology of California*. Second edition, John Wiley & Sons, Inc. New York.

Norwood, Richard

2003 Quarterly Report to MAJCOM on the status of the Edwards Air Force Base Cultural Resource Program. Summary spreadsheet prepared by Richard Norwood, Base Historic Preservation Officer, Edwards Air Force Base, California. December.

Oakeshott, Gordon B.

1978 *California's Changing Landscapes: A Guide to the Geology of the State.* McGraw-Hill Publishing Company, New York.

Oak Ridge National Laboratory (ORNL)

2000 *Ecological Risk Assessment Framework for Low-Altitude Overflights by Fixed Wing and Rotary Wing Military Aircraft.* Document No. ORNL/TM-2000/289, ES-5048. Environmental Sciences Division, Oak Ridge, Tennessee.

Pater, Larry

1976 "Noise Abatement Programs for Explosive Operations at NSWC/DL", presented at the 17th Explosive Safety Seminar of the DoD Explosives Safety Board.

Port of Oakland

2004 Quarterly Noise Monitoring Report, Metropolitan Oakland International Airport. Oakland, California. October–December 2003.

Reinke, Dan

2005 Personal communications concerning the expected flights by aircraft using PB-13 for armed munitions integration and test flights. May.

Ronning, M.R., M.D. Pittman, and J. Underwood

2000 *Cultural Resources Overview and Management Plan for Edwards AFB, California*, Volume 3: *Cultural Resources Management Plan*. Computer Sciences Corporation, Edwards Air Force Base, California. Submitted to AFFTC, Base Historic Preservation Office, Edwards Air Force Base, California.

Stanford Alumni

2005 Home Page. "How Fast and High Do Birds Fly?" Accessed at http://www.stanfordalumni.org/birdsite/text/essays/How_Fast.html.

Smith, L.

2005 Personal communications regarding roles and responsibilities of the Safety Office. May.

United States Census Bureau

2000 "2000 Census," http://www.census.gov/main/www/cen2000.html (accessed March 2004).

United States Fauna

2005 Article on "Mohave Ground Squirrel" http://www.unitedstatesfauna.com/ mohavegroundsquirrel.php (accessed May).

U.S. Air Force

1995 *Environmental Compliance Assessment and Management Program (ECAMP), Preliminary Environmental Findings for Edwards AFB, California*. Prepared by AFFTC/EMC Environmental Compliance Division, April. Document on file at AFFTC/EM, Edwards AFB, CA.

U.S. Air Force

1997 *Final Environmental Impact Statement for the Program Definition and Risk Reduction Phase of the Airborne Laser Program: Volume 1*. Kirtland Air Force Base, New Mexico. April.

U.S. Air Force

2000 USAF/AFMC Memorandum for SMC/TMS from AFRL/HEDO (Brooks AFB, TX) regarding Preliminary Unclassified Hazards Analysis for ABL Systems Ground Testing at Edwards AFB, CA. October.

U.S. Air Force

2002a *Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations.* Institute for Environment, Safety, and Occupational Health Risk Analysis. January.

U.S. Air Force

2002b High Energy Laser Target Reflection Hazard Analysis: Lance and FMA Missiles. May.

U.S. Air Force

2003a Information from the annual Air Emissions Inventory for Edwards Air Force Base.

U.S. Air Force

2003b Consulative Letter, AFRL-HE-BR-CL-2003-0017, Precision Impact Range Area (PIRA) Laser Safety Survey, Edwards AFB CA. 29 October.

U.S. Air Force

2005 Information from the 2004 annual Air Emissions Inventory for Edwards Air Force Base. On file with 95 ABW/CEVX.

U.S. Army

2000 *Common Risk Criteria for National Test Ranges Subtitle: Inert Debris*. Risk and Lethality Commonality Team, Range Safety Group, Range Commanders Council. Supplement to Standard 321-00. April.

U.S. Army

2001 *Environmental Noise Management, An Orientation Handbook for Army Facilities*. U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). May.

U.S. Army

2004a Noise Levels for Common Army Equipment. U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). Accessed online at http://chppm-www.apgea.army.mil/hcp/NoiseLevelsPrint.htm.

U.S. Army

2004b *Supplemental Draft Environmental Impact Statement National Training Center, Ft. Irwin, CA.* Ft. Irwin, CA. p. 4-67. January.

U.S. Army Corps of Engineers (USACE)

1994 *Repair Rosamond Boulevard, Edwards Air Force Base, California, Study of Alternatives*. Document on file at AFFTC/EM, Edwards AFB, CA. April.

U.S. Army Corps of Engineers (USACE)

1996 *Delineation and Characterization of "Waters of the United States" at Edwards Air Force Base, California*. Waterways Experiment Station. pp. 1–81.

U.S. Army Corps of Engineers (USACE)

1997 *The Grazing and Cropland Management Plan for Edwards Air Force Base, California*. Document on file at AFFTC/EM, Edwards AFB, CA.

U.S. Army Corps of Engineers and Air Force Flight Test Center (USACE and AFFTC)

1994 *Programmatic Environmental Assessment for the Comprehensive Plan of Edwards Air Force Base*, July. Document on file at AFFTC/EM, Edwards AFB, CA.

U.S. Census Bureau

2000 *Profiles of General Demographics Characteristics, 2000 Census of Population and Housing*. U.S. Department of Commerce.

U.S. Department of Agriculture (USDA), Soil Conservation Service

1998 *Interim, Soil Survey of Edwards Air Force Base, California*. Document on file at AFFTC/EM, Edwards AFB, CA.

U.S. Department of Energy (DOE)

2001 Department of Energy Web Site, http://www.eia.doe.gov. December.

U.S. Department of Housing and Urban Development (HUD)

1978 Environmental Criteria and Standards, Section 51.101.9.

U.S. Environmental Protection Agency

1974 *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*. EPA-550/9-47-004.

U.S. Environmental Protection Agency

1991 *Compilation of Air Pollutant Emission Factors, AP-42*, Volume II, Part I, Appendix N, *Diesel Powered, Transit Buses*. March.

U.S. Environmental Protection Agency

2000 *AP-42: Compilation of Emission Air Pollutant Factors* Volume II: *Mobile Sources*. Updated November 24, 2000.

U.S. Fish and Wildlife Service

1991 *Biological Opinion for Routine Operations and Facility Construction within the Cantonment Areas of Main and South Bases, Edwards AFB, California (1-6-91-28)*. On file at 95 ABW/EM, Edwards AFB, CA.

U.S. Fish and Wildlife Service

1994a *Biological Opinion for the Precision Impact Range Area, Edwards Air Force Base, California*, March. Document on file at AFFTC/EM, Edwards AFB, CA.

U.S. Fish and Wildlife Service

1994b *Guidelines for Handling Desert Tortoises During Construction Projects*. Document on file at 95 ABW/EM, Edwards AFB, CA.

U.S. Fish and Wildlife Service

1996 *Request for Amendment of the Biological Opinion (1-8-94-F-6) for the Precision Impact Range Area, Edwards Air Force Base, California*. February. Document on file at AFFTC/EM, Edwards AFB, CA.

U.S. Forest Service

2004 http://www.fs.fed.us. Accessed December 2004.

U.S. Geological Survey (USGS)

1998 *Topography, Surface Features, and Flooding of Rogers Lake Playa, California*. Document on file at AFFTC/EM, Edwards AFB, CA.

U.S. Geological Survey (USGS)

2001 U.S. Geological Survey Web Site, http://www.usgs.gov/. December. (accessed April 2004).

Weichel, Hugo

1990 Laser Beam Propagation in the Atmosphere. August.

Wilson, Sonja

2004 Personal communication concerning the expected number of lifting entry vehicle flights through 2010. May.

Weston, Roy F.

1986 *Water Supply Availability and Distribution System Evaluation, Edwards AFB, CA*. February. Document on file at 95 ABW/CEV Environmental Management Division library.

6.0 PERSONS AND AGENCIES CONTACTED

Bransfield, Ray

2006 Personal communications. Conference call to discuss recommendations for environmental effects on natural resources. U.S. Fish and Wildlife Service Office, Ventura, California. March.

Congo, William

2005 Personal communication. U.S. Army Space and Missile Defense Command Public Affairs Office, Huntsville, Alabama. January.

Hagenauer, Larry

2005 Personal and electronic communication. January.

Mattson, Paul

2004 Personal communication on ABL. Tybrin Corporation. Edwards AFB. December.

Montoya, Kevin

2004 Personal communication on laser testing and integration requirements. 412 TW/EWA, Edwards, AFB. November.

Morgan, Dan

2005 Personal communication on Unmanned Aerial Vehicles (UAV). January.

Mork, Brian

2004 Personal communication on laser technology. Tybrin Corporation, Edwards, AFB. November.

Schwedland, Ron

2005 Personal communication regarding the FJ44-2 engine used in the Proteus. Director of Business Development, Williams International, LLC. January/February.

Wilson, Sonja

2004 Tybrin Corporation, Edwards AFB. May.

Wimmer, Joseph

2005 Personal e-mail communication on laser characteristics. Airborne Laser and Diagnostics Manager. Washington, D.C. January.

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8.0 ACRONYMS AND ABBREVIATIONS

412 TW	412th Test Wing
412 TW/ENROR	412th Test Wing/Range Safety Office
95 ABW	95th Air Base Wing
95 ABW/CEV	95th Air Base Wing/Environmental Management Division
95 AMDS/SGPB	Bioenvironmental Flight Office
A/A	air-to-air
A/G	air-to-ground
A/S	air-to-space
ABL	Airborne Laser
ACTD	Advanced Concept Technology Demonstration
AEC	areas of environmental concern
AF	Air Force
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
AFFTC	U.S. Air Force Flight Test Center
AFI	Air Force Instruction
AFIERA	Air Force Institute for Environment, Safety and Occupational Health Risk Analysis
AFOSH	Air Force Occupational Safety and Health
AFRL	Air Force Research Lab
AGE	aerospace ground equipment
AGL	above ground level
AICUZ	air installation compatible use zone
ANSI	American National Standards Institute
APZ	accident potential zone
ARS	active ranging system
ARTCC	Air Route Traffic Control Center
ATC	Air Traffic Control
ATL	Advanced Tactical Laser
AVAQMD	Antelope Valley Air Quality Management District
AVEK	Antelope Valley East Kern

BASH	bird/aircraft strike hazard
BFTF	Birk Flight Test Facility
BHP	basic hydrogen peroxide
BILL	beacon illuminator laser
BLM	Bureau of Land Management

CAA	Clean Air Act
CAAQS	California Ambient Air Quality Standards
Cal/EPA	California Environmental Protection Agency
Cal/OSHA	California Occupational Health and Safety Administration
CARB	California Air Resources Board
CCF	Central Coordinating Facility
CCR	California Code of Regulations
CDNL	C-weighted day-night level
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	controlled firing area
CFR	Code of Federal Regulations
CHABA	Committee on Hearing, Bioacoustics and Biomechanics
CNEL	community noise equivalent level
CNPS	California Native Plant Society
CO	carbon monoxide
COIL	chemical oxygen iodine laser
CSEL	C-weighted sound exposure level

dB	decibels
dBA	A-weighted decibels
dBC	C-weighted decibels
dBP	peak sound level
DE	directed energy
DFRC	Dryden Flight Research Center
DNL	day-night average noise level (also L_{dn})
DoD	Department of Defense
DOSH	California Department of Occupational Safety and Health

DTSC	Department of Toxic Substances Control
DWMA	Desert Wildlife Management Area
EA	environmental assessment
EIAP	Environmental Impact Analysis Process
EM	Environmental Management
EMR	electromagnetic radiation
EO	Executive Order
EPCRA	Emergency Planning-and-Community-Right-to-Know Act
ESA	Endangered Species Act
°F	degrees Fahrenheit
FAA	Federal Aviation Administration
FICUN	Federal Interagency Committee on Urban Noise
FL	flight level
FONSI	Finding of No Significant Impact
FP	firing position
FSO	free space optics
G/A	ground-to-air
G/G	ground-to-ground
G/S	ground-to-space
GBUAPCD	Great Basin Unified Air Pollution Control District
GPRA	Ground Pressure Recovery Assembly
GSE	ground support equipment
HEL	high-energy laser
HMMWV	high mobility multi-wheeled vehicle (Hummer)
HUD	Department of Housing and Urban Development
Hz	hertz
IFR	instrument flight rules
IMF	integrated maintenance facility

INRMP	Integrated Natural Resources Management Plan
IR	infrared, Instrument Route
IRP	Installation Restoration Program
KCAPCD	Kern County Air Pollution Control District
kW	kilowatt
L_{eq}	long-term equivalent A-weighted sound level
LFZ	laser-free zone
LGAC	laser generated air contaminant
LHZ	laser-hazard zone
L_{max}	A-weighted single event sound level
LSDZ	laser surface danger zone
LTA	laser target area
LTO	landing and takeoff
MARSA	military assumes responsibility for separation of aircraft
MBTA	Migratory Bird Treaty Act
MDAB	Mojave Desert Air Basin
MDAQMD	Mojave Desert Air Quality Management District
mgd	million gallons per day
µm	micrometer
MOA	Military Operations Area
MPE	maximum permissible exposure
MSL	mean sea level
mW	milliwatt
MW/cm^2	megawatts per square centimeter
NAAQS	National Ambient Air Quality Standards
NACO	National Aeronautical Charting Office
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NAWS	Naval Air Weapons Station

Nd:YAG	neodymium: yttrium, aluminum, garnet
NEPA	National Environmental Policy Act
NO_x	nitrogen oxides
NO_2	nitrogen dioxide
NOHD	nominal ocular hazard distance
NOHZ	nominal ocular hazard zone
NOTAM	Notice to Airmen
NRHP	National Register of Historic Places
NTC	National Training Center
ONRL	Oak Ridge National Laboratory
OU	operable unit
PEL	permissible exposure limit
PIRA	Precision Impact Range Area
P.L.	Public Law
$PM_{2.5}$	particulate matter 2.5 microns or less in diameter
PM_{10}	particulate matter 10 microns or less in diameter
POL	petroleum, oil, and lubricant
PPR	prior permission required
PSD	Prevention of Significant Deterioration
RCRA	Resource Conservation and Recovery Act
RFR	radio frequency radiation
ROI	Region of Influence
S/A	space-to-air
S/G	space-to-ground
SEA	Significant Ecological Area
SEL	sound exposure level
SHEL	surrogate high energy laser
SIL	System Integration Laboratory
SIP	State Implementation Plan

SJVAPCD	San Joaquin Valley Air Pollution Control District
SO_2	sulfur dioxide
SUA	special use airspace
TCP	traditional cultural property
TGO	touch and go
THOR	TeraHertz Operational Reachback
TILL	track illuminator laser
TRACON	Terminal Radar Approach Control
UAV	unmanned aerial vehicle
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
U.S. EPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UV	ultraviolet
VFR	visual flight rules
VOC	volatile organic compound
VR	Visual Route
W	watts
W/cm^3	watts per cubic centimeter
WWTP	Waste Water Treatment Plant
YLF	yttrium lithium fluoride

A AIR EMISSIONS ANALYSIS

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Table A-1
ABL (Boeing 747) Aircraft Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
ABL (Boeing 747)	CF6-80C2B1F	4	LTO	Takeoff (Mil)	320.37	0.11	54.98	0.09	0.10	19.40
				Climb Out (Int)	262.30	0.11	23.63	0.09	0.10	9.92
				Approach	85.98	0.24	27.49	4.70	0.10	-
				Idle (Taxi)	26.19	3.62	10.43	42.40	0.10	-

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	0.70	0.10	49.32	0.08	0.09	17.40
		2.20	0.25	54.54	0.21	0.22	22.90
		4.00	0.33	37.82	6.47	0.13	-
		26.00	9.86	28.41	115.49	0.26	-
Total Emissions Per Mission (lbs)			***10.54***	***170.09***	***122.24***	***0.70***	***40.30***

Source: All data were extracted from the *Final Environmental Impact Statement for the Program Definition and Risk Reduction Phase of the Airborne Laser Program*, Volume 1, April 1997.

Table A-2
AC-130 Aircraft Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
AC-130	T-56-A-15	4	LTO	Takeoff (Mil)	40.93	0.28	11.42	1.77	0.10	1.22
				Climb Out (Int)	36.33	0.42	9.69	1.65	0.10	1.46
				Approach	20.67	0.58	8.31	2.82	0.10	3.85
				Idle (Taxi-in)	15.00	1.97	7.49	3.84	0.10	3.64
				Idle (Taxi-out)	15.00	1.97	7.49	3.84	0.10	3.64

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	1.00	0.05	1.87	0.29	0.02	0.20
		1.50	0.09	2.11	0.36	0.02	0.32
		5.00	0.24	3.44	1.17	0.04	1.59
		15.00	1.77	6.74	3.46	0.09	3.28
		30.00	3.55	13.48	6.91	0.17	6.55
Total Emissions Per Mission (lbs)			***5.70***	***27.64***	***12.18***	***0.34***	***11.94***

Source: All data were extracted from the *Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations*, published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002.

Table A-3
B1-B (Lancer) Aircraft Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	**NOx**	**CO**	**SOx**	**PM_{10}**
B1-B (Lancer)	F101-GE-102	4	LTO	Takeoff (Mil)	130.47	0.11	12.83	0.83	0.10	1.68
				Climb Out (Int)	109.28	0.13	13.15	0.85	0.10	1.35
				Approach	75.55	0.14	9.16	1.03	0.10	4.23
				Idle (Taxi)	18.62	-	4.10	24.47	0.10	2.17

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	**NOx**	**CO**	**SOx**	**PM_{10}**
LTO	1	0.40	0.02	2.68	0.17	0.02	0.35
		0.80	0.05	4.60	0.30	0.03	0.47
		3.50	0.15	9.69	1.09	0.10	4.47
		29.80	-	9.10	54.30	0.21	4.82
Total Emissions Per Mission (lbs)			***0.22***	***26.06***	***55.86***	***0.37***	***10.11***

Note: SOx was calculated based on sulfur content for West Coast (0.048) of the fuel multiplied by the factor 20 rounded up.

Source: All data were extracted from the Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations, published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002.

Table A-4
H-47 Helicopter Activity and Emissions for Edwards AFB

Helicopter Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
H-47 (CH-47)	T55-L712	2	LTO	Climb Out (Int)	11.77	0.39	8.61	3.09	0.10	2.60
				Approach	11.77	0.39	8.61	3.09	0.10	2.60
				Idle (Taxi-in)	2.22	56.67	2.78	53.18	0.10	1.48
				Idle (Taxi-out)	2.22	56.67	2.78	53.18	0.10	1.48

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	10.00	0.09	2.03	0.73	0.02	0.61
		10.00	0.09	2.03	0.73	0.02	0.61
		10.00	2.52	0.12	2.36	0.00	0.07
		10.00	2.52	0.12	2.36	0.00	0.07
Total Emissions Per Mission (lbs)			***5.22***	***4.30***	***6.18***	***0.05***	***1.36***

Source: Exact emissions for the H-47 (CH-47) Army Helicopter could not be located. Therefore, the information provided for the T700-GE-700 was used to estimate the emissions for the H-47. The T700 series of engines are used in several other helicopters including the AH-1W, the AH-64, and the Blackhawk. All data were extracted from the *Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations*, published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002. The "Ground Idle" power setting was assumed for both idle scenarios and the "Overspeed" power setting was assumed for both climb-out and approach to be conservative.

Table A-5
MV-22 Aircraft Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Emission Factors (lbs/sortie)	
			NOx	PM_{10}
MV-22	T406-AD-400	2	0.31	0.70

	Sorties per Mission	Emisions (lbs)	
		NOx	PM_{10}
	1	0.31	0.70
Total Emissions Per Mission (lbs)		***0.31***	***0.70***

Source: Data were obtained from Edwards AFB personnel who obtained it from Catherine Kim, V-22 Environmental Program Coordinator, Naval Air Warfare Center, Aircraft Division, Lakehurst, New Jersey.

Table A-6
F-22 Aircraft Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow[a] (lbs/min)	Emission Factors[b] (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
F-22	F-119-PW-100	2	LTO	Takeoff (Mil)	168.40	0.24	39.12	1.33	0.10	1.61
				Climb Out (Int)	126.95	0.31	27.60	1.05	0.10	2.81
				Approach	45.77	0.85	13.82	3.17	0.10	1.46
				Idle (Taxi-in)	18.28	54.82	4.99	123.75	0.10	4.48
				Idle (Taxi-out)	18.28	54.82	4.99	123.75	0.10	4.48

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	1.00	0.08	13.18	0.45	0.03	0.54
		1.00	0.08	7.01	0.27	0.02	0.71
		5.00	0.39	6.33	1.45	0.04	0.67
		15.00	30.06	2.74	67.86	0.05	2.46
		25.00	50.11	4.56	113.11	0.09	4.09
Total Emissions Per Mission (lbs)			***80.72***	***33.81***	***183.14***	***0.24***	***8.48***

Notes: No data verifying emissions estimates are currently available for the F-35; therefore, it was suggested by Edwards AFB personnel that emission estimates for the F-22 engine be used. Tetra Tech personnel found it equally difficult to locate emission factors for the F-22 engine. Therefore, a worst case scenario was developed based on information available for the F-15, F-16, and F-18 aircraft engines. The F-22 is expected to use more fuel than previous aircraft to obtain additional thrust, but to burn the fuel more efficiently, thereby producing fewer emissions.

a - Of the F-15, F-16, and F-18, the F-15 was determined to have the highest overall fuel flow for the majority of the operation modes and was therefore used to simulate F-22 emissions.

b - Of the F-15, F-16, and F-18, use of the F-18 emission factors was determined to be most conservative (i.e., resulted in the most emissions) for reactive organic gases (ROCs), carbon monoxide (CO), and particulate matter less than 10 microns in diameter (PM_{10}), while use of the F-16 emission factor for nitrogen oxides (NOx) proved to be most conservative.

Source: All data were extracted from the *Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations,* published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002.

Table A-7
F-35 Aircraft Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow[a] (lbs/min)	Emission Factors[b] (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
F-35 (Use F-22 Data)	F-119-PW-100	2	LTO	Takeoff (Mil)	168.40	0.24	39.12	1.33	0.10	1.61
				Climb Out (Int)	126.95	0.31	27.60	1.05	0.10	2.81
				Approach	45.77	0.85	13.82	3.17	0.10	1.46
				Idle (Taxi-in)	18.28	54.82	4.99	123.75	0.10	4.48
				Idle (Taxi-out)	18.28	54.82	4.99	123.75	0.10	4.48

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	1.00	0.08	13.18	0.45	0.03	0.54
		1.00	0.08	7.01	0.27	0.02	0.71
		5.00	0.39	6.33	1.45	0.04	0.67
		15.00	30.06	2.74	67.86	0.05	2.46
		25.00	50.11	4.56	113.11	0.09	4.09
Total Emissions Per Mission (lbs)			***80.72***	***33.81***	***183.14***	***0.24***	***8.48***

Note: No data verifying emissions estimates are currently available for the F-35; therefore, it was suggested by Edwards AFB personnel that emission estimates for the F-22 engine be used. Tetra Tech personnel found it equally difficult to locate emission factors for the F-22 engine. Therefore, a worst case scenario was developed based on information available for the F-15, F-16, and F-18 aircraft engines. The F-35 is expected to use more fuel than previous aircraft to obtain additional thrust, but to burn the fuel more efficiently, thereby, producing fewer emissions.

a - Of the F-15, F-16, and F-18, the F-15 was determined to have the highest overall fuel flow for the majority of the operation modes and was therefore used to simulate F-35 emissions.

b - Of the F-15, F-16, and F-18, use of the F-18 emission factors was determined to be most conservative (i.e., resulted in the most emissions) for reactive organic gases (ROGs), carbon monoxide (CO), and particulate matter less than 10 microns in diameter (PM_{10}), while use of the F-16 emission factor for nitrogen oxides (NOx) proved to be most conservative.

Source: All data were extracted from the *Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations* , published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002.

Table A-8
UAV (F-18) Aircraft Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
UAV (F-18)	F404-GE-400	2	LTO	Takeoff (Mil)	126.95	0.24	22.27	1.33	0.10	1.61
				Climb Out (Int)	108.38	0.31	25.16	1.05	0.10	2.81
				Approach	51.83	0.85	7.14	3.17	0.10	1.46
				Idle (Taxi-in)	10.90	54.82	1.43	123.75	0.10	4.48
				Idle (Taxi-out)	10.90	54.82	1.43	123.75	0.10	4.48

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	1.00	0.06	5.65	0.34	0.02	0.41
		1.00	0.07	5.45	0.23	0.02	0.61
		5.00	0.44	3.70	1.64	0.05	0.76
		15.00	17.93	0.47	40.47	0.03	1.46
		25.00	29.88	0.78	67.44	0.05	2.44
Total Emissions Per Mission (lbs)			***48.37***	***16.06***	***110.12***	***0.18***	***5.68***

Source: All data were extracted from the *Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations*, published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002.

Table A-9
T-38 Aircraft Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
T-38 (AT/T-38)	J-85-GE-5	2	LTO	Takeoff (Mil)	46.92	0.52	4.66	28.98	0.10	1.13
				Climb Out (Int)	35.92	0.64	5.67	28.38	0.10	1.13
				Approach	17.85	3.04	2.86	93.67	0.10	1.79
				Idle (Taxi-in)	8.43	15.34	2.11	158.22	0.10	4.70
				Idle (Taxi-out)	8.43	15.34	2.11	158.22	0.10	4.70
			TGO	Takeoff (Mil)	46.92	0.52	4.66	28.98	0.10	1.13
				Climb Out (Int)	35.92	0.64	5.67	28.38	0.10	1.13
				Approach	17.85	3.04	2.86	93.67	0.10	1.79

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	1.00	0.05	0.44	2.72	0.01	0.11
		1.00	0.05	0.41	2.04	0.01	0.08
		5.00	0.54	0.51	16.72	0.02	0.32
		15.00	3.88	0.53	40.01	0.02	1.19
TGO	1	1.00	0.05	0.44	2.72	0.01	0.11
		0.50	0.02	0.20	1.02	0.00	0.04
		4.00	0.43	0.41	13.38	0.01	0.26
Total Emissions Per Mission (lbs)			***5.02***	***2.94***	***78.61***	***0.08***	***2.10***

Source: All data were extracted from the *Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations*, published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002.

Table A-10
F-15 Aircraft Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
F-15	F-100-PW-100	2	LTO	Takeoff (Mil)	168.40	0.28	39.44	0.90	0.10	1.33
				Climb Out (Int)	126.95	0.14	30.89	0.91	0.10	2.06
				Approach	45.77	0.16	12.33	3.49	0.10	2.63
				Idle (Taxi-in)	18.28	8.60	4.38	35.29	0.10	2.06
				Idle (Taxi-out)	18.28	8.60	4.38	35.29	0.10	2.06
			TGO	Takeoff (Mil)	168.40	0.28	39.44	0.90	0.10	1.33
				Climb Out (Int)	126.95	0.14	30.89	0.91	0.10	2.06
				Approach	45.77	0.16	12.33	3.49	0.10	2.63

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	1.00	0.09	13.28	0.30	0.03	0.45
		1.00	0.04	7.84	0.23	0.02	0.52
		5.00	0.07	5.64	1.60	0.04	1.20
		25.00	7.86	4.00	32.26	0.09	1.88
TGO	1	1.00	0.09	13.28	0.30	0.03	0.45
		0.50	0.02	3.92	0.12	0.01	0.26
		4.00	0.06	4.51	1.28	0.04	0.96
Total Emissions Per Mission (lbs)			***8.23***	***52.49***	***36.08***	***0.27***	***5.73***

Source: All data were extracted from the *Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations*, published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002.

Table A-11
F-16 Aircraft Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
F-16	F-100-PW-200	1	LTO	Takeoff (Mil)	145.28	0.13	39.12	0.86	0.10	1.33
				Climb Out (Int)	90.10	0.22	27.60	0.49	0.10	2.06
				Approach	52.25	0.26	13.82	1.38	0.10	2.63
				Idle (Taxi-in)	16.98	8.28	4.99	26.61	0.10	2.06
				Idle (Taxi-out)	16.98	8.28	4.99	26.61	0.10	2.06
			TGO	Takeoff (Mil)	145.28	0.13	39.12	0.86	0.10	1.33
				Climb Out (Int)	90.10	0.22	27.60	0.49	0.10	2.06
				Approach	52.25	0.26	13.82	1.38	0.10	2.63

Number of Operations	Operation Cycle	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
1	LTO	1.00	0.02	5.68	0.12	0.01	0.19
		1.00	0.02	2.49	0.04	0.01	0.19
		5.00	0.07	3.61	0.36	0.03	0.69
		25.00	3.51	2.12	11.30	0.04	0.87
1	TGO	1.00	0.02	5.68	0.12	0.01	0.19
		0.50	0.01	1.24	0.02	0.00	0.09
		4.00	0.05	2.89	0.29	0.02	0.55
Total Emissions Per Mission (lbs)			***3.70***	***23.71***	***12.26***	***0.13***	***2.78***

Source: All data were extracted from the *Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations* , published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002.

Table A-12
Proteus Aircraft Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
Proteus	FJ44-2	2	LTO	Takeoff (Mil)	27.17	0.48	17.95	2.87	0.10	2.52
				Climb Out (Int)	22.65	0.49	15.48	2.48	0.10	3.15
				Approach	8.27	0.97	6.10	6.28	0.10	3.55
				Idle (Taxi-in)	3.68	2.28	2.42	32.08	0.10	4.98
				Idle (Taxi-out)	3.68	2.28	2.42	32.08	0.10	4.98

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	1.00	0.03	0.98	0.16	0.01	0.14
		1.00	0.02	0.70	0.11	0.00	0.14
		2.00	0.03	0.20	0.21	0.00	0.12
		10.00	0.17	0.18	2.36	0.01	0.37
		10.00	0.17	0.18	2.36	0.01	0.37
Total Emissions Per Mission (lbs)			***0.42***	***2.23***	***5.20***	***0.03***	***1.13***

Source: "Time in Mode" and "Fuel Flowrate" data were extracted from AP-42, Compilation of Air Pollutant Emissions Factors, Volume II: Mobile Sources, U.S. Environmental Protection Agency, Ann Arbor, Michigan, September 1985. Because "Fuel Flowrate" information for the FJ44-2 engine was not available, data for the JT15D-5B engine were substituted as a conservative estimate, as these engines are similar in size and thrust. Emission Factors were provided by Mr. Ron Schwedland, Director of Business Development with Williams International, LLC, the manufacturer of the FJ44-2 engine. No particulate information was provided; therefore, particulate emission factors for the JT15D-5B were used.

Table A-13
Total Expected Aircraft Emissions

			Emissions (tons/yr)				
Year			**VOC**	**NO_2**	**CO**	**SO_2**	**PM_{10}**
2006							
Mission Aircraft		Flights					
ABL		20	0.105	1.701	1.222	0.007	0.403
AC-130		10	0.028	0.138	0.061	0.002	0.060
B1-B		0	0.000	0.000	0.000	0.000	0.000
H-47		10	0.026	0.022	0.031	0.000	0.007
MV-22		5	0.000	0.001	0.000	0.000	0.002
F-22		5	0.202	0.085	0.458	0.001	0.021
F-35		0	0.000	0.000	0.000	0.000	0.000
UAV		10	0.242	0.080	0.551	0.001	0.028
	total	60	0.604	2.026	2.323	0.010	0.521
Chase Aircraft							
T-38		16	0.040	0.024	0.629	0.001	0.017
F-15		22	0.091	0.577	0.397	0.003	0.063
F-16		22	0.041	0.261	0.135	0.001	0.031
	total	60	0.172	0.862	1.161	0.005	0.110
Target Aircraft							
Proteus		20	0.004	0.022	0.052	0.000	0.011
	total	20	0.004	0.022	0.052	0.000	0.011
Total			***0.779***	***2.910***	***3.535***	***0.016***	***0.642***
2007							
Mission Aircraft		Flights					
ABL		20	0.105	1.701	1.222	0.007	0.403
AC-130		10	0.028	0.138	0.061	0.002	0.060
B1-B		0	0.000	0.000	0.000	0.000	0.000
H-47		10	0.026	0.022	0.031	0.000	0.007
MV-22		5	0.000	0.001	0.000	0.000	0.002
F-22		5	0.202	0.085	0.458	0.001	0.021
F-35		10	0.404	0.169	0.916	0.001	0.042
UAV		10	0.242	0.080	0.551	0.001	0.028
	total	70	1.007	2.195	3.238	0.012	0.563
Chase Aircraft							
T-38		19	0.048	0.028	0.747	0.001	0.020
F-15		25	0.103	0.656	0.451	0.003	0.072
F-16		26	0.048	0.308	0.159	0.002	0.036
	total	70	0.199	0.992	1.357	0.006	0.128
Target Aircraft							
Proteus		23	0.005	0.026	0.060	0.000	0.013
	total	23	0.005	0.026	0.060	0.000	0.013
Total			***1.211***	***3.213***	***4.655***	***0.018***	***0.704***

Table A-13, Page 1 of 2

Table A-13
Total Expected Aircraft Emissions (Continued)

		Emissions (tons/yr)				
Year		**VOC**	**NO_2**	**CO**	**SO_2**	**PM_{10}**
2008						
Mission Aircraft	Flights					
ABL	40	0.211	3.402	2.445	0.014	0.806
AC-130	20	0.057	0.276	0.122	0.003	0.119
B1-B	0	0.000	0.000	0.000	0.000	0.000
H-47	20	0.052	0.043	0.062	0.001	0.014
MV-22	10	0.000	0.002	0.000	0.000	0.003
F-22	10	0.404	0.169	0.916	0.001	0.042
F-35	20	0.807	0.338	1.831	0.002	0.085
UAV	20	0.484	0.161	1.101	0.002	0.057
total	*140*	*2.014*	*4.390*	*6.477*	*0.023*	*1.126*
Chase Aircraft						
T-38	38	0.095	0.056	1.494	0.002	0.040
F-15	50	0.206	1.312	0.902	0.007	0.143
F-16	52	0.096	0.617	0.319	0.003	0.072
total	140	0.398	1.985	2.714	0.012	0.255
Target Aircraft						
Proteus	47	0.010	0.053	0.122	0.001	0.027
total	47	0.010	0.053	0.122	0.001	0.027
Total		***2.422***	***6.428***	***9.313***	***0.036***	***1.408***
2009 and 2010 (each year)						
Mission Aircraft	Flights					
ABL	69	0.364	5.868	4.217	0.024	1.390
AC-130	19	0.054	0.263	0.116	0.003	0.113
B1-B	5	0.001	0.065	0.140	0.001	0.025
H-47	19	0.050	0.041	0.059	0.001	0.013
MV-22	10	0.000	0.002	0.000	0.000	0.003
F-22	9	0.363	0.152	0.824	0.001	0.038
F-35	19	0.767	0.321	1.740	0.002	0.081
UAV	19	0.460	0.153	1.046	0.002	0.054
total	169	2.058	6.864	8.141	0.034	1.718
Chase Aircraft						
T-38	45	0.113	0.066	1.769	0.002	0.047
F-15	61	0.251	1.601	1.101	0.008	0.175
F-16	63	0.117	0.747	0.386	0.004	0.087
total	169	0.481	2.414	3.255	0.014	0.309
Target Aircraft						
Proteus	56	0.012	0.063	0.146	0.001	0.032
total	56	0.012	0.063	0.146	0.001	0.032

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Table A-14

ZEUS-HLONS Mobile Source Emissions

Equipment or Vehicle Type	Number of Vehicles	HP	Vehicle Miles Traveled	Number of Missions	Year	NO_2 Emission Factor (g/mi)	Total NO_2 Emissions (tons/yr)	SO_2 Emission Factor (g/mi)	Total SO_2 Emissions (tons/yr)	CO Emission Factor (g/mi)	Total CO Emissions (tons/yr)	VOC Emission Factor (g/mi)	Total VOC Emissions (tons/yr)	PM_{10} Exhaust Emission Factor (g/mi)	Total PM_{10} Exhaust Emissions (tons/yr)	PM_{10} Fugitive Emission Factor (g/mi)	Total PM_{10} Fugitive Emissions (tons/yr)	Total PM_{10} Emissions (tons/yr)
ZEUS-HLONS (hybrid diesel/electric HMMWV, LDDT[a])	1	150 at 3,600 RPM	50	24	2006	1.0	***0.0013***	0.157	***0.0002***	1.3	***0.0017***	0.4	***0.001***	0.109	0.0001	1.48	0.0020	***0.0021***
					2007	1.0	***0.0013***	0.157	***0.0002***	1.3	***0.0017***	0.4	***0.001***	0.109	0.0001	1.48	0.0020	***0.0021***
					2008	1.0	***0.0013***	0.157	***0.0002***	1.3	***0.0017***	0.4	***0.001***	0.109	0.0001	1.48	0.0020	***0.0021***
					2009	1.0	***0.0013***	0.157	***0.0002***	1.3	***0.0017***	0.4	***0.001***	0.109	0.0001	1.48	0.0020	***0.0021***
					2010	1.0	***0.0013***	0.157	***0.0002***	1.3	***0.0017***	0.4	***0.001***	0.109	0.0001	1.48	0.0020	***0.0021***

Source: Based on personal communication with Mr. William Congo with the U.S. Army Space and Missile Defense Command Public Affairs Office in Huntsville, Alabama (January 2005), it was determined that no emission estimates for the hybrid HMMWV have been established. He further concurred that use of emission estimates currently available for the standard HMMWV would provide a conservative estimate. Therefore, emission factors were extracted from the *Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations*, published by the United State Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis in January 2002.

Notes:
a - The LDDT Class includes vehicles with gross vehicle weights of 8,500 pounds or less. The HMMWV has a gross vehicle weight of 5,200 pounds.
CO - carbon monoxide
HMMWV - high-mobility multipurpose wheeled vehicle
LDDT - light-duty diesel truck
NO_2 - nitrogen dioxide
PM_{10} - particulate matter equal to or below 10 microns
SO_2 - sulfur dioxide
VOC - volatile organic compounds

Table A-15

Related Stationary Source Emissions (on ground)

Year - 2006

Process Description	Fuel Type	Power Rating (BTU/hr)	Operation (hrs/mission)	Flights	NO_2 (lb/MMBtu)	NO_2 Emission Rate (tons/year)	CO (lb/MMBtu)	CO Emission Rate (ton/year)	SO_2 (lb/MMBtu)	SO_2 Emission Rate (ton/year)	PM_{10} (lb/MMBtu)	PM_{10} Emission Rate (ton/year)	VOC Emission Factor (lb/MMBtu)	VOC Emission Rate (ton/year)
Generator (A/M32A-60B)	JP-8	3,543,300												
ABL			3.0	20	0.698	0.074	0.048	0.005	0.0505	0.005	0.061	0.006	0.017	0.002
AC-130			2.0	10	0.698	0.025	0.048	0.002	0.0505	0.002	0.061	0.002	0.017	0.001
H-47			1.5	10	0.698	0.019	0.048	0.001	0.0505	0.001	0.061	0.002	0.017	0.000
MV-22			1.5	5	0.698	0.009	0.048	0.001	0.0505	0.001	0.061	0.001	0.017	0.000
F-22			1.5	5	0.698	0.009	0.048	0.001	0.0505	0.001	0.061	0.001	0.017	0.000
F-35			1.5	0	0.698	0.000	0.048	0.000	0.0505	0.000	0.061	0.000	0.017	0.000
UAV			2.5	10	0.698	0.031	0.048	0.002	0.0505	0.002	0.061	0.003	0.017	0.001
T-38			0.2	16	0.698	0.004	0.048	0.000	0.0505	0.000	0.061	0.000	0.017	0.000
total				***76***		***0.171***		***0.012***		***0.012***		***0.015***		***0.004***

Year - 2007

Process Description	Fuel Type	Power Rating (BTU/hr)	Operation (hrs/mission)	Flights	NO_2 (lb/MMBtu)	NO_2 Emission Rate (tons/year)	CO (lb/MMBtu)	CO Emission Rate (ton/year)	SO_2 (lb/MMBtu)	SO_2 Emission Rate (ton/year)	PM_{10} (lb/MMBtu)	PM_{10} Emission Rate (ton/year)	VOC Emission Factor (lb/MMBtu)	VOC Emission Rate (ton/year)
Generator (A/M32A-60B)	JP-8	3,543,300												
ABL			3.0	20	0.698	0.074	0.048	0.005	0.0505	0.005	0.061	0.006	0.017	0.002
AC-130			2.0	10	0.698	0.025	0.048	0.002	0.0505	0.002	0.061	0.002	0.017	0.001
H-47			1.5	10	0.698	0.019	0.048	0.001	0.0505	0.001	0.061	0.002	0.017	0.000
MV-22			1.5	5	0.698	0.009	0.048	0.001	0.0505	0.001	0.061	0.001	0.017	0.000
F-22			1.5	5	0.698	0.009	0.048	0.001	0.0505	0.001	0.061	0.001	0.017	0.000
F-35			1.5	10	0.698	0.019	0.048	0.001	0.0505	0.001	0.061	0.002	0.017	0.000
UAV			2.5	10	0.698	0.031	0.048	0.002	0.0505	0.002	0.061	0.003	0.017	0.001
T-38			0.2	19	0.698	0.005	0.048	0.000	0.0505	0.000	0.061	0.000	0.017	0.000
total				***89***		***0.190***		***0.013***		***0.014***		***0.017***		***0.005***

Notes:
Source: Mr. Darrell Stiff, Chief, Powered Aircraft Ground Equipment, 412 Equipment Maintenance Squadron, Edwards AFB, CA. Personl correspondence with Mr. Larry Hagenauer, EAFB Environmental Contractor, 18 Aug 2004.
BTU - British thermal units
CO - carbon monoxide
lb/s - pound/s
NO_2 - nitrogen dioxide
PM_{10} - particulate matter equal to or below 10 microns
SO_2 - sulfur dioxide
VOC - volatile organic compounds

Table A-15

Related Stationary Source Emissions (on ground)

Year - 2008

Process Description	Fuel Type	Power Rating (BTU/hr)	Operation (hrs/mission)	Flights	NO_2 (lb/MMBtu)	NO_2 Emission Rate (tons/year)	CO (lb/MMBtu)	CO Emission Rate (ton/year)	SO_2 (lb/MMBtu)	SO_2 Emission Rate (ton/year)	PM_{10} (lb/MMBtu)	PM_{10} Emission Rate (ton/year)	VOC Emission Factor (lb/MMBtu)	VOC Emission Rate (ton/year)
Generator (A/M32A-60B)	JP-8	3,543,300												
ABL			3.0	40	0.698	0.148	0.048	0.010	0.0505	0.011	0.061	0.013	0.017	0.004
AC-130			2.0	20	0.698	0.049	0.048	0.003	0.0505	0.004	0.061	0.004	0.017	0.001
H-47			1.5	20	0.698	0.037	0.048	0.003	0.0505	0.003	0.061	0.003	0.017	0.001
MV-22			1.5	10	0.698	0.019	0.048	0.001	0.0505	0.001	0.061	0.002	0.017	0.000
F-22			1.5	10	0.698	0.019	0.048	0.001	0.0505	0.001	0.061	0.002	0.017	0.000
F-35			1.5	20	0.698	0.037	0.048	0.003	0.0505	0.003	0.061	0.003	0.017	0.001
UAV			2.5	20	0.698	0.062	0.048	0.004	0.0505	0.004	0.061	0.005	0.017	0.002
T-38			0.2	40	0.698	0.010	0.048	0.001	0.0505	0.001	0.061	0.001	0.017	0.000
total				***180***		***0.381***		***0.026***		***0.028***		***0.033***		***0.009***

Years - 2009 and 2010 (per year)

Process Description	Fuel Type	Power Rating (BTU/hr)	Operation (hrs/mission)	Flights	NO_2 (lb/MMBtu)	NO_2 Emission Rate (tons/year)	CO (lb/MMBtu)	CO Emission Rate (ton/year)	SO_2 (lb/MMBtu)	SO_2 Emission Rate (ton/year)	PM_{10} (lb/MMBtu)	PM_{10} Emission Rate (ton/year)	VOC Emission Factor (lb/MMBtu)	VOC Emission Rate (ton/year)
Generator (A/M32A-60B)	JP-8	3,543,300												
ABL			3.0	69	0.698	0.256	0.048	0.018	0.0505	0.019	0.061	0.022	0.017	0.006
AC-130			2.0	19	0.698	0.047	0.048	0.003	0.0505	0.003	0.061	0.004	0.017	0.001
B1-B			3.0	5	0.698	0.019	0.048	0.001	0.0505	0.001	0.061	0.002	0.017	0.000
H-47			1.5	19	0.698	0.035	0.048	0.002	0.0505	0.003	0.061	0.003	0.017	0.001
MV-22			1.5	10	0.698	0.019	0.048	0.001	0.0505	0.001	0.061	0.002	0.017	0.000
F-22			1.5	9	0.698	0.017	0.048	0.001	0.0505	0.001	0.061	0.001	0.017	0.000
F-35			1.5	19	0.698	0.035	0.048	0.002	0.0505	0.003	0.061	0.003	0.017	0.001
UAV			2.5	19	0.698	0.059	0.048	0.004	0.0505	0.004	0.061	0.005	0.017	0.001
T-38			0.2	45	0.698	0.011	0.048	0.001	0.0505	0.001	0.061	0.001	0.017	0.000
total				***214***		***0.497***		***0.034***		***0.036***		***0.043***		***0.012***

Notes:
Source: Mr. Darrell Stiff, Chief, Powered Aircraft Ground Equipment, 412 Equipment Maintenance Squadron, Edwards AFB, CA. Personl correspondence with Mr. Larry Hagenauer, EAFB Environmental Contractor, 18 Aug 2004.
BTU - British thermal units
CO - carbon monoxide
lb/s - pound/s
NO_2 - nitrogen dioxide
PM_{10} - particulate matter equal to or below 10 microns
SO_2 - sulfur dioxide

Table A-16

Related Mobile Source Emissions (on ground)

Year - 2006

Equipment or Vehicle Type	Rate of Emissions	Number of Vehicles	HP	Vehicle Miles Traveled: Paved	Vehicle Miles Traveled: Unpaved	Number of Missions	Hours per Day	Emission Type	NO_2 Emission Factor[a]	Total NO_2 Emissions (tons/yr)	SO_2 Emission Factor[a]	Total SO_2 Emissions (tons/yr)	CO Emission Factor[a]	Total CO Emissions (tons/yr)	VOC Emission Factor[a]	Total VOC Emissions (tons/yr)	PM_{10} Emission Factor[a]	Total PM_{10} Emissions (tons/yr)	Entrained PM_{10} Emission Factor[b] (lbs/VMT): Paved	Entrained PM_{10} Emission Factor[b] (lbs/VMT): Unpaved	Total Entrained PM_{10} Emissions (tons/yr)
LDGV, LDGT, &HDGT	g/VMT	3	N/A	40	10	60	N/A	Travel	0.90	0.01	-	-	8.87	0.09	0.91	0.01	0.11	0.00	0.02	0.78	0.76
	g/VMT							Cold Start	2.77	0.03	-	-	93.49	0.93	5.21	0.05	-	-	-	-	-
	g/VMT							Hot Start	1.76	0.02	-	-	12.74	0.13	1.38	0.01	-	-	-	-	-
	g/VMT							Hot Soak	-	-	-	-	-	-	2.11	0.02	-	-	-	-	-
	g/VMT							Diurnal	-	-	-	-	-	-	5.01	0.05	-	-	-	-	-
LDDT	g/VMT	1	N/A	40	10	60	N/A	Travel	12.01	0.04	-	-	11.03	0.04	2.78	0.01	2.63	0.01	0.02	0.78	0.25
	g/VMT							Cold Start	-	-	-	-	-	-	-	-	-	-	-	-	-
	g/VMT							Hot Soak	-	-	-	-	-	-	-	-	-	-	-	-	-
	g/VMT							Diurnal	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL Emissions in tons/year										***0.094***		***-***		***1.178***		***0.154***		***0.010***			***1.014***

Year - 2007

Equipment or Vehicle Type	Rate of Emissions	Number of Vehicles	HP	Vehicle Miles Traveled: Paved	Vehicle Miles Traveled: Unpaved	Number of Missions	Hours per Day	Emission Type	NO_2 Emission Factor[a]	Total NO_2 Emissions (tons/yr)	SO_2 Emission Factor[a]	Total SO_2 Emissions (tons/yr)	CO Emission Factor[a]	Total CO Emissions (tons/yr)	VOC Emission Factor[a]	Total VOC Emissions (tons/yr)	PM_{10} Emission Factor[a]	Total PM_{10} Emissions (tons/yr)	Entrained PM_{10} Emission Factor[b] (lbs/VMT): Paved	Entrained PM_{10} Emission Factor[b] (lbs/VMT): Unpaved	Total Entrained PM_{10} Emissions (tons/yr)
LDGV, LDGT, &HDGT	g/VMT	3	N/A	40	10	70	N/A	Travel	0.90	0.01	-	-	8.87	0.10	0.91	0.01	0.11	0.00	0.02	0.78	0.89
	g/VMT							Cold Start	2.77	0.03	-	-	93.49	1.08	5.21	0.06	-	-	-	-	-
	g/VMT							Hot Start	1.76	0.02	-	-	12.74	0.15	1.38	0.02	-	-	-	-	-
	g/VMT							Hot Soak	-	-	-	-	-	-	2.11	0.02	-	-	-	-	-
	g/VMT							Diurnal	-	-	-	-	-	-	5.01	0.06	-	-	-	-	-
LDDT	g/VMT	1	N/A	40	10	70	N/A	Travel	12.01	0.05	-	-	11.03	0.04	2.78	0.01	2.63	0.01	0.02	0.78	0.30
	g/VMT							Cold Start	-	-	-	-	-	-	-	-	-	-	-	-	-
	g/VMT							Hot Soak	-	-	-	-	-	-	-	-	-	-	-	-	-
	g/VMT							Diurnal	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL Emissions in tons/year										***0.109***		***-***		***1.375***		***0.180***		***0.011***			***1.183***

Notes:

a - Emission factors were obtained using EMFAC 7G.

b - Emission factors for the LDGV, LDGT, HDGT, and LDDT were obtained from AP-42 Emission Facotrs, December 2003.

CO - carbon monoxide

HDGT - heavy-duty gasoline truck

LDDT - light-duty diesel truck

LDGT - light-duty gasoline truck

LDGV - light-duty gasoline vehicle

NO_2 - nitrogen dioxide

PM_{10} - particulate matter equal to or below 10 microns

SO_2 - sulfur dioxide

VOC - volatile organic compounds

Table A-16

Related Mobile Source Emissions (on ground)

Year - 2008

Equipment or Vehicle Type	Rate of Emissions	Number of Vehicles	HP	Vehicle Miles Traveled		Number of Missions	Hours per Day	Emission Type	NO_2 Emission Factor[a]	Total NO_2 Emissions (tons/yr)	SO_2 Emission Factor[a]	Total SO_2 Emissions (tons/yr)	CO Emission Factor[a]	Total CO Emissions (tons/yr)	VOC Emission Factor[a]	Total VOC Emissions (tons/yr)	PM_{10} Emission Factor[a]	Total PM_{10} Emissions (tons/yr)	Entrained PM_{10} Emission Factor[b] (lbs/VMT)		Total Entrained PM_{10} Emissions (tons/yr)
				Paved	Unpaved														Paved	Unpaved	
LDGV, LDGT, &HDGT	g/VMT	3	N/A	40	10	140	N/A	Travel	0.90	0.02	-	-	8.87	0.21	0.91	0.02	0.11	0.00	0.02	0.78	1.77
	g/VMT							Cold Start	2.77	0.06	-	-	93.49	2.16	5.21	0.12	-	-	-	-	-
	g/VMT							Hot Start	1.76	0.04	-	-	12.74	0.29	1.38	0.03	-	-	-	-	-
	g/VMT							Hot Soak	-	-	-	-	-	-	2.11	0.05	-	-	-	-	-
	g/VMT							Diurnal	-	-	-	-	-	-	5.01	0.12	-	-	-	-	-
LDDT	g/VMT	1	N/A	40	10	140	N/A	Travel	12.01	0.09	-	-	11.03	0.09	2.78	0.02	2.63	0.02	0.02	0.78	0.59
	g/VMT							Cold Start	-	-	-	-	-	-	-	-	-	-	-	-	-
	g/VMT							Hot Soak	-	-	-	-	-	-	-	-	-	-	-	-	-
	g/VMT							Diurnal	-	-	-	-	-	-	-	-	-	-	-	-	-
						TOTAL Emissions in tons/year				***0.218***		***-***		***2.750***		***0.360***		***0.023***			***2.366***

Years - 2009 and 2010 (per year)

Equipment or Vehicle Type	Rate of Emissions	Number of Vehicles	HP	Vehicle Miles Traveled		Number of Missions	Hours per Day	Emission Type	NO_2 Emission Factor[a]	Total NO_2 Emissions (tons/yr)	SO_2 Emission Factor[a]	Total SO_2 Emissions (tons/yr)	CO Emission Factor[a]	Total CO Emissions (tons/yr)	VOC Emission Factor[a]	Total VOC Emissions (tons/yr)	PM_{10} Emission Factor[a]	Total PM_{10} Emissions (tons/yr)	Entrained PM_{10} Emission Factor[b] (lbs/VMT)		Total Entrained PM_{10} Emissions (tons/yr)
				Paved	Unpaved														Paved	Unpaved	
LDGV, LDGT, &HDGT	g/VMT	3	N/A	40	10	169	N/A	Travel	0.90	0.03	-	-	8.87	0.25	0.91	0.03	0.11	0.00	0.02	0.78	2.14
	g/VMT							Cold Start	2.77	0.08	-	-	93.49	2.61	5.21	0.15	-	-	-	-	-
	g/VMT							Hot Start	1.76	0.05	-	-	12.74	0.36	1.38	0.04	-	-	-	-	-
	g/VMT							Hot Soak	-	-	-	-	-	-	2.11	0.06	-	-	-	-	-
	g/VMT							Diurnal	-	-	-	-	-	-	5.01	0.14	-	-	-	-	-
LDDT	g/VMT	1	N/A	40	10	169	N/A	Travel	12.01	0.11	-	-	11.03	0.10	2.78	0.03	2.63	0.02	0.02	0.78	0.71
	g/VMT							Cold Start	-	-	-	-	-	-	-	-	-	-	-	-	-
	g/VMT							Hot Soak	-	-	-	-	-	-	-	-	-	-	-	-	-
	g/VMT							Diurnal	-	-	-	-	-	-	-	-	-	-	-	-	-
						TOTAL Emissions in tons/year				***0.264***		***-***		***3.319***		***0.434***		***0.028***			***2.856***

Notes:

a - Emission factors were obtained using EMFAC 7G.

b - Emission factors for the LDGV, LDGT, HDGT, and LDDT were obtained from AP-42 Emission Facotrs, December 2003.

CO - carbon monoxide

HDGT - heavy-duty gasoline truck

LDDT - light-duty diesel truck

LDGT - light-duty gasoline truck

LDGV - light-duty gasoline vehicle

NO_2 - nitrogen dioxide

PM_{10} - particulate matter equal to or below 10 microns

SO_2 - sulfur dioxide

VOC - volatile organic compounds

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B ANALYSIS OF LASER ENERGY AT TEST RANGES

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Appendix B Excerpts from the ABL Environmental Impact Statement (Listed as Appendix F, Pages F-1 through F-24)

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APPENDIX F

ANALYSIS OF LASER ENERGY AT TEST RANGES

Introduction

This appendix presents a general overview and preliminary results of the analysis of health and safety risks from the reflections of high-energy laser (HEL) discharges produced during the flight-testing of the PDRR ABL Phase. Following the overview is an attachment which repeats some of the material presented in Appendix F but includes a more detailed presentation of the analysis for the technical reader.

The use of a multi-megawatt, chemical oxygen iodine laser (COIL) on a B747 aircraft to destroy theater-ballistic missiles in boost phase at a distance of hundreds of kilometers requires careful consideration to ensure the health and safety of project personnel, the public, and biological resources. The purpose of this preliminary analysis is to determine if it is possible to conduct a safe test. The analysis demonstrates that neither HEL beam propagation nor the reflections from targets would pose undue health and safety risks to workers, the public, or biological resources.

Laser Energy Safety Standards

The *American National Standard for Safe Use of Lasers*, ANSI Z136.1, 1993, is the recognized national and DoD safety standard for laser operations (DoD, 1993 and Range Commanders Council, 1991). The term used to define safe exposure is *maximum permissible exposure* (MPE). The MPE is a radiance density expressed in joules/cm^2, and is defined in ANSI Z136.1 as "the level of laser radiation to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin." The MPE values given in the standard are below known hazardous levels. Exposure to levels at MPE values may be uncomfortable to view or feel but is not harmful.

The MPE levels defined in the standard are related to the type and wavelength of the laser. Laser types are *continuous wave* and *pulsed*. Lasers operating with a continuous output for a period greater than or equal to 0.25 seconds are regarded as continuous wave (CW) lasers. The COIL used in the PDRR ABL Phase is a CW laser with a wavelength of 1.315 μm. Chapter 8 of ANSI Z136.1 defines the safety criteria for laser exposure to eye and skin. For non-visible wavelengths (less than 0.4μm or greater than 0.7μm), the CW exposure duration is the maximum time of anticipated exposure. The estimated engagement times for laser operations during PDRR ABL flight tests range from 3 to 10 seconds. Tables 5 and 6 of ANSI Z136.1 define the MPE for ocular exposure (intrabeam viewing) to a laser beam. For ABL laser operations, the maximum permissible exposure limit defined in these tables is:

$$MPE = 9.0 * C_c * t^{3/4} * 10^{-3} \text{ (joules/cm}^2\text{)}$$

t = exposure duration in seconds

C_c = correction factor (8.0 for wavelengths 1.200 to 1.400 μm)

Missile Engagement Geometry and Missile Targets

This health and safety analysis focuses on the laser energy reflected off a target. The possibility of public exposure to hazardous levels of *direct*, non-reflected laser energy would be eliminated by the decision to restrict laser firings to angles at and above the horizontal plane from the PDRR ABL aircraft's altitude of 40,000 ft. The targets in all HEL engagement scenarios during the PDRR ABL Phase would be flying at altitudes greater than 40,000 ft.

Targets are of two types: target boards and missiles. Target boards would be carried to altitude by either drone aircraft or unmanned balloons. They would be stabilized in flight to present a flat, vertical surface for the impinging laser energy. Because the vertical target board would be at an altitude greater than the PDRR ABL, the engagement geometry would preclude downward reflections. Two classes of target missiles would be used: solid-propellant (Terrier-Black Brant and Terrier-Orion), and liquid-propellant (Lance). The solid-propellant missiles have maximum altitudes of greater than 200 km (124 mi) and launch angles of greater than 85 degrees. The Lance missile only achieves a 45-km (28 mi) peak altitude and a launch angle of approximately 54 degrees. Direct laser energy that misses the target would continue upward and eventually exit the earth's atmosphere.

An additional safeguard is that all testing would be done within the confines of DoD test ranges in airspace controlled by the test range. Prior to laser firings the test plans showing projected location of aircraft, targets, and laser-beam paths would have to be approved by Range Safety. Test plans for laser firing would include an analysis of orbiting satellite locations to ensure that none is damaged. As the PDRR ABL Phase matures over the next 5 years prior to flight testing and as more detailed test plans and scenarios are developed, additional analyses would be performed to ensure that the tests would be conducted safely.

Reflection of HEL Energy

Because of the missile's flight path angle when intercepted by the laser beam, HEL reflections from the target-missile surface could be directed downward (Figure F-1). Therefore, an evaluation of the reflected HEL energy is necessary.

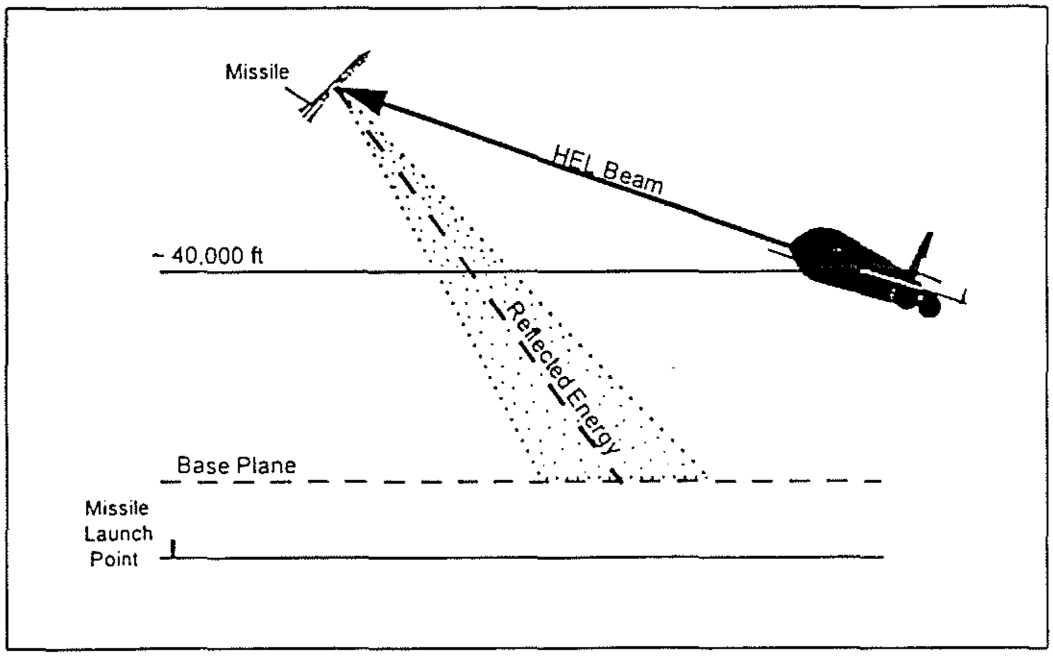

Figure F-1. PDRR ABL Missile Engagement Scenario

The reflected laser energy from the target missile may be transmitted in three different modes: *diffuse*, *specular*, and *glint*. Each mode needs to be analyzed individually. Diffuse reflections occur from laser impact on a minimally reflective target. The resultant reflected energy is then distributed outward over a spherical surface, similar to the way that a light bulb's energy is dispersed. Specular reflection is the reflection off of a highly reflective surface (polished metal, mirror, etc.). The specular reflections from the cylindrical body of the missile form a pie-shaped wedge. The primary dispersing factor is the curved surface of the missile. Glint reflections occur from very small, flat, perfectly reflective surfaces. The typical size of the reflective surface used for analysis purposes is one square centimeter. Reflected glint energy forms a conical pattern as it travels from the reflective surface. The conical energy pattern does not disperse rapidly. Figure F-2 shows each of the reflected energy patterns.

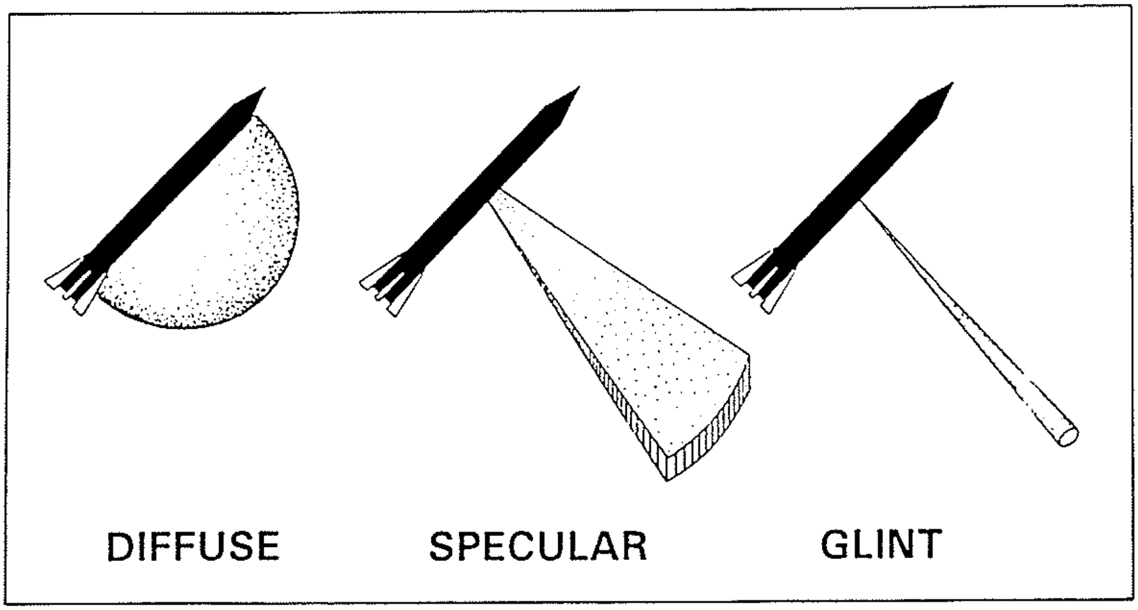

Figure F-2. Reflected Energy Patterns

The angle of the missile's reflecting surface to the oncoming HEL energy is dependent on the missile's position in its trajectory, and therefore target-reflection analysis must: 1) calculate the angular orientation of the reflected beam, and 2) estimate the reflected laser radiance density. *Radiance* is energy emitted, transferred or received in the form of electromagnetic radiation, and is expressed in joules. *Radiance density* is radiance per unit area, expressed in joules/cm^2. This reflected energy density is then compared to the maximum permissible exposure levels defined in the *American National Standard for Safe Use of Lasers*, ANSI Standard Z136.1-1993.

Safety Analysis for Diffuse Laser Reflection

As shown by the equation on page F-1, calculation of MPE level requires knowledge of the exposure duration (t). Because the wavelength of the COIL is in the near-infrared region (0.7 - 1.4 μm), ANSI Z136.1 recommends that an exposure duration of 10 seconds be used in safety calculations. This duration is applicable for diffusely-reflected energy because the engagement time of the laser test is estimated to be between 3 and 10 seconds. Also, because the diffusely-reflected energy is spread over a large area, the energy density rapidly decreases to below MPE levels. Calculations in the attachment to Appendix F show that for a 10-second exposure, the reflected energy drops to below MPE levels within 50 meters (approximately 165 ft) of the target missile. Because the missile is traveling at more than 500 meters per second (approximately 1,120 mph) above 40,000 ft altitude, there would be no biological organism capable of receiving a 10-second exposure.

Safety Analysis for Specular and Glint Laser Reflection. The MPE durations for specular and glint reflections are more difficult to calculate. Factors that must be included in the analysis are: 1) velocity of the target missile, 2) vertical and horizontal position and angular rotation of the missile during flight, 3) relative position of the PDRR ABL aircraft to the missile, and 4) location of the observer relative to the missile. The ABL aircraft is traveling at speeds in excess of 300 miles per hour and the target missile at speeds in excess of 1,100 miles per hour. The specular and glint reflected energy would therefore sweep across the surface of the earth at high velocities in a relatively tight pattern. Potential exposure durations to project personnel, the public, or biological resources from both specular and glint reflections are very short. For the Lance target missile, maximum potential exposure durations were calculated to be less than 0.01 second.

To simplify the MPE calculations and the determination of safe locations during PDRR ABL HEL engagements, the concept of a "base plane" is used (Figure F-3). The base plane is an imaginary horizontal surface at an altitude of 10,000 ft. All biological resources (human or animal) are likely to be located below this altitude. If it can be shown that the reflected-laser radiant energy density levels are below MPE levels at the base plane, then no reflected-laser safety constraints exist to prevent the testing of the PDRR ABL HEL. Because Range Operations has control of the airspace, and radar and visual checks of the airspace are made prior to any test to ensure that it is clear, the only biological resources that could occupy the airspace are birds. Data obtained from the USAF Bird Air Strike Hazard Team indicate that 95 percent of the birds fly below an altitude of 2,500 feet. Therefore, a base-plane altitude selection of 10,000 ft is conservative. To further simplify the calculations, the values of reflected laser radiance density and MPE are calculated for the most hazardous location on the base plane. Reflected, laser-radiant energy density levels at other locations on the base plane would be less than at themost hazardous location. Therefore, if the most hazardous location can be shown to be safe, then all other locations on the base plane would also be safe.

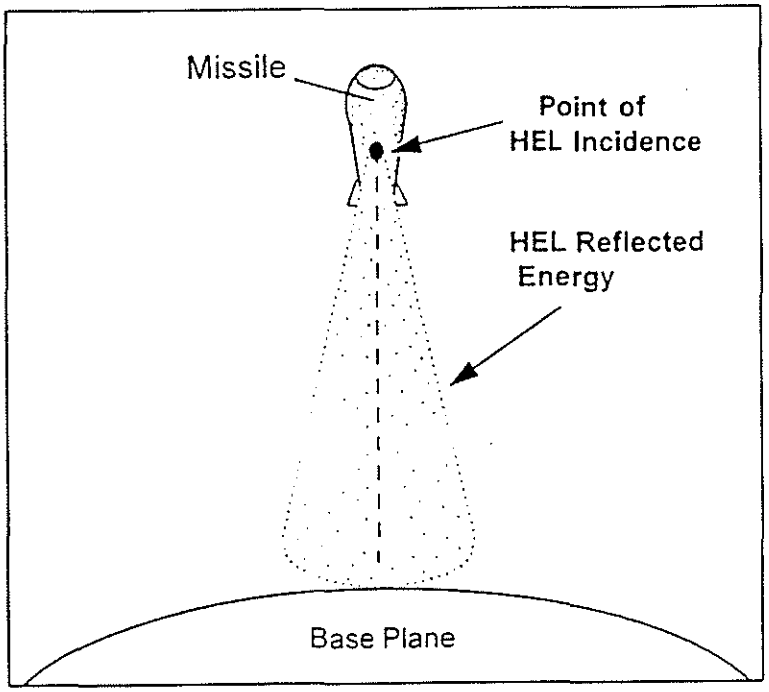

Figure F-3. Reflected Laser Energy Projection on the Base Plane

The scenario and assumptions used in this analysis are:

- The PDRR ABL aircraft is orbiting 200 km (124 mi) from the target missile's launch point
- The target is a Lance missile
- There is no atmospheric attenuation of the laser beam's energy
- The surface of the missile is 100 percent reflective
- When the laser beam reaches the target missile, it has 1 megawatt of power and a circular profile with a diameter of 30 cm, and the energy in the beam is uniformly distributed (i.e., when graphed as intensity vs. position across the beam it displays a squared-off or "top hat" profile).

A comparison of radiance values and MPE values for spectral and glint reflections with respect to missile-flight time at the most hazardous location on a base plane are shown in Figures F-4 and F-5.

Figures F-4 and F-5 are graphical representations of the analysis presented in Attachment 1 of this appendix. Note that time values begin at 17 seconds because the Lance missile takes nearly 17 seconds to climb to an altitude of 40,000 ft, the minimum altitude for HEL engagements. The boost phase of the Lance missile lasts until approximately 30 seconds after launch. This is the period in which the ABL weapon system would engage the missile. It should be noted that during the period of potential engagement, the reflected laser is located between 11 and 22 km (7 and 14 mi) downrange from the launch point over the Pacific Ocean, and the velocity of the reflected laser energy on the base plane is greater than 1,100 mph (see Table FA-1 in the attachment to this appendix). The results presented in the two figures show that the radiance levels for both specular and glint reflections at the base plane are well below the MPE values for a HEL engagement of a Lance missile.

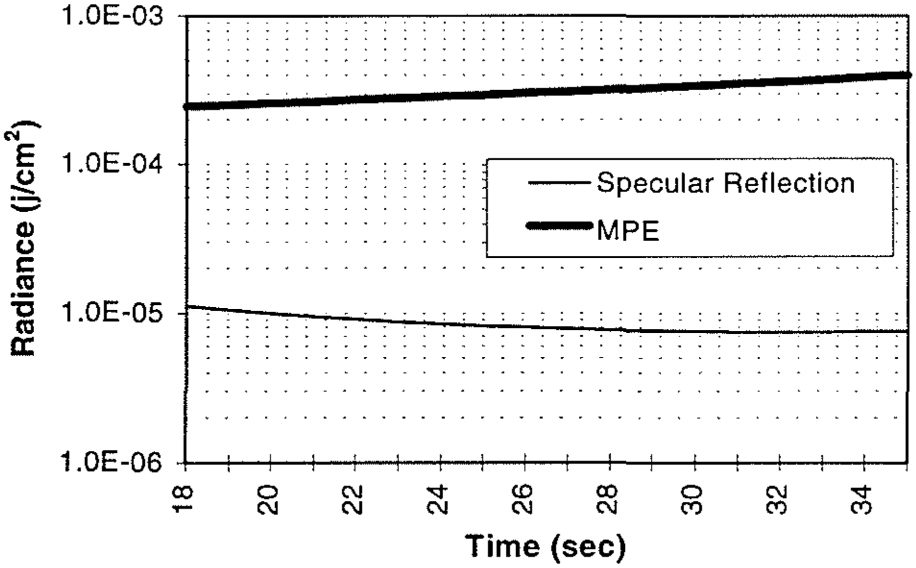

Figure F-4. Radiance Level of Specular Reflection at the Base Plane

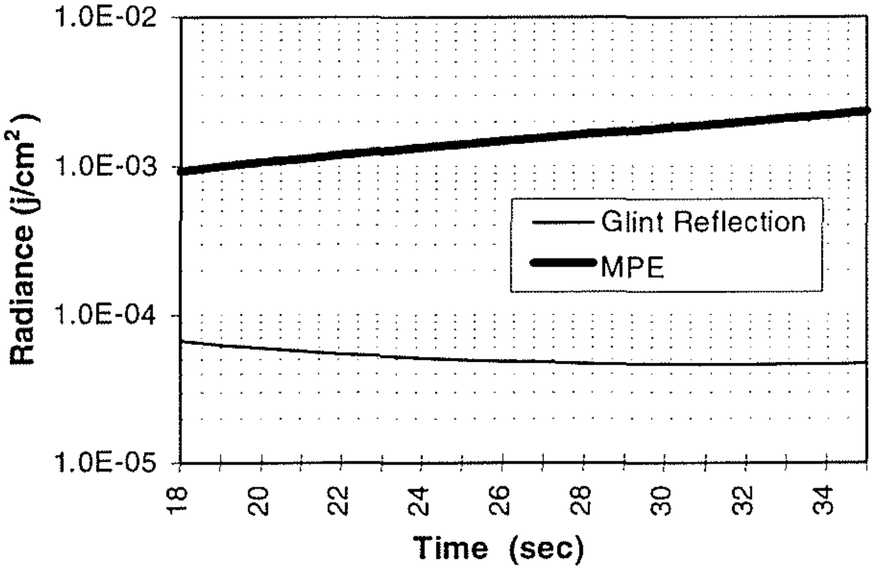

Figure F-5. Radiance Level of Glint Reflection at the Base Plane

Conclusions

The analysis demonstrates that reflected, HEL radiant-energy density levels in diffuse, spectral and glint modes, would be less than the MPE at a base plane at 10,000 ft, and therefore less than the MPE at the earth's surface. It would, therefore, be possible to conduct a test of the HEL weapon system and not pose unacceptable health or safety risks to program personnel, the public, or biological resources.

As each HEL test is planned, analysis of reflected, laser-energy patterns and radiance levels would be an integral part of the effort. Prior to an actual test, data must be submitted to the range-safety office. These data would include laser system parameters, test description, laser-illumination exposure analysis, and a risk analysis that describes all applicable and reasonable hazards and failure modes. Range Safety would review the data and make the final decision on whether the test should proceed.

The analysis presented in this appendix was reviewed by the Optical Radiation Division, USAF Armstrong Laboratory (USAF, 1996) and their conclusions were:

> "We believe the conclusion of the ABL-PDRR safety analysis to be valid for the scenario given; i.e., assuming the beam is fired up at the missile, removing any possibility of direct intrabeam exposure at lower elevations, and assuming that the numbers used for missile and laser beam parameters in the specular and glint-hazard analyses are accurate. In this scenario, specular, glint and diffuse reflections would appear to pose no hazard to humans or animals located at or below the base plane."

ATTACHMENT TO APPENDIX F
ANALYSIS OF REFLECTED LASER ENERGY

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ATTACHMENT TO APPENDIX F

ANALYSIS OF REFLECTED LASER ENERGY

Introduction

Appendix F presents a general overview and preliminary results of the analysis of health and safety risks from the reflections of high-energy laser (HEL) discharges produced during the flight-testing of the PDRR ABL Phase. This attachment to Appendix F repeats some parts of the appendix but provides a detailed analysis for the technical reader. It quantifies the radiant-energy density of the reflected-laser energy and the maximum permissible exposure (MPE) levels (joules per cm^2) at the most hazardous location on the base plane, an imaginary horizontal plane at an altitude of 10,000 ft (Sliney and Wolbarsht, 1982). A glossary of symbols used in the equations appears at the end of this analysis.

Laser Energy Safety Standards and Maximum Permissible Exposure (MPE)

The American National Standard for Safe Use of Lasers, ANSI Z136.1-1993, provides guidance for the safe use of lasers and laser systems. Both the HEL and the illuminator lasers used in the PDRR ABL weapon system are Class 4 lasers and can be hazardous to the eye or skin from direct beam and sometimes from the reflected energy. Tables 5 and 6 in ANSI Z136.1-1993 define the MPE for ocular exposure (intrabeam viewing) to a laser beam. Since the wavelength of the HEL beam is 1.315 μm and the exposure durations are between 50 μ sec and 1,000 seconds (in contrast to the 3 to 10 seconds of engagement time), the MPE is:

$$\text{MPE} = 9.0 * C_c * t^{3/4} * 10^{-3} \text{ (joules/cm}^2\text{)}$$

where

t = exposure duration, t_d, t_s or t_g

C_c = 8.0 ("correction factor") from Table 6, ANSI Z136.1-1993

Missile Engagement Geometry

Figure FA-1 and FA-2 show the geometry of the PDRR ABL HEL engagement scenario used in this analysis. Figure FA-1 shows the ABL aircraft and target-missile geometry, and Figure FA-2 shows the target-missile, incident and reflected HEL-beam geometry.

The "center line" is an imaginary line following the center of the reflected-laser energy. The target's center-line angle of the spectral or glint-reflected laser energy (ϕ) is dependent on two variables. Those variables are the HEL beam's angle of incident inclined upward from the horizontal (θ), and the flight-path angle (β) of the missile (Figure FA-2). Both the spectral and glint reflections will spread out due to the curvature of the missile body and to the natural divergence of laser energy. The divergence is equal to the wavelength of the laser energy divided by the diameter of the source aperture (λ/d).

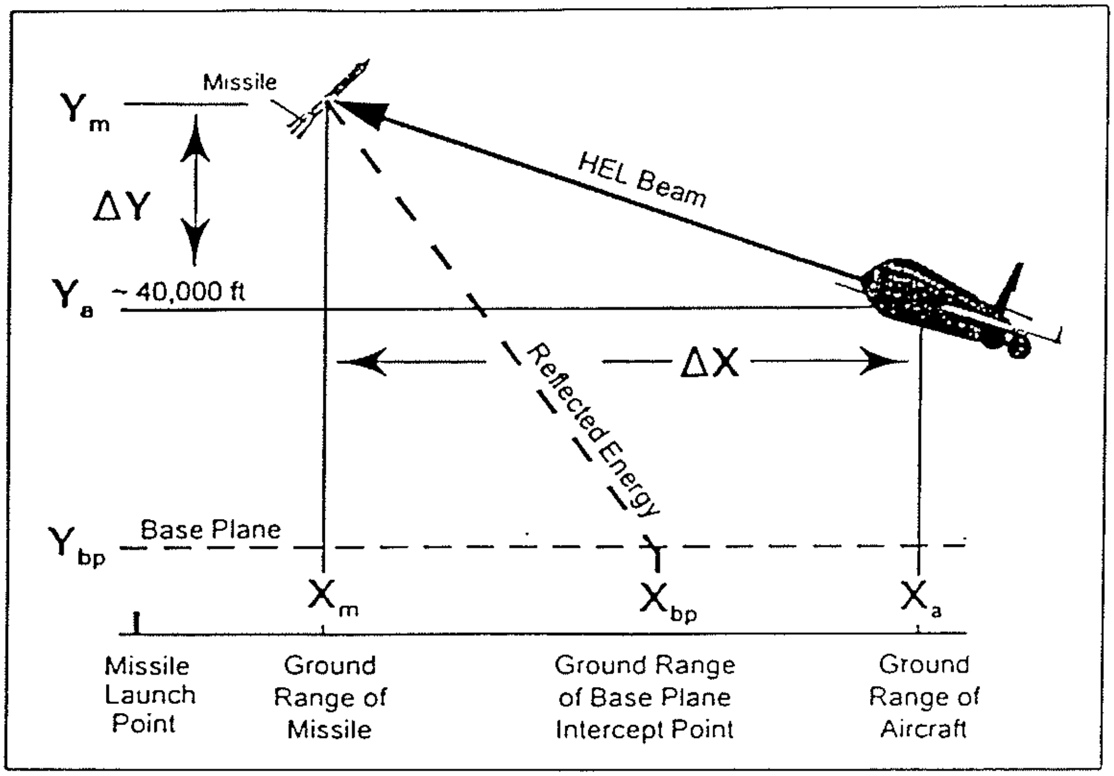


Figure FA-1. Geometry of Missile and ABL Aircraft Locations

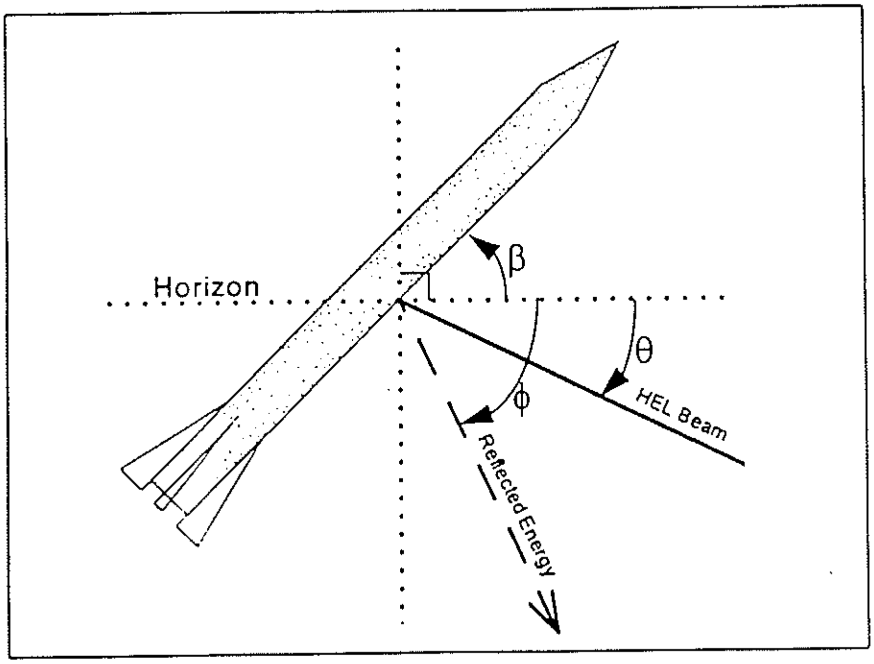


Figure FA-2. Reflected Laser Energy Geometry for the HEL Beam

The calculation of the incident angle of the HEL beam is as follows:

$$\theta = \text{ArcTAN}\left(\frac{\Delta Y}{\Delta X}\right) \quad \text{(Eq-1)}$$

where

$\Delta Y = Y_m - Y_a$

$\Delta X = X_m - X_a$

Y_m = altitude of missile

Y_a = altitude of PDRR ABL aircraft

X_a = ground range of PDRR ABL aircraft

X_m = ground range of missile

The calculation of the reflection angle from horizontal of the reflected energy's center line is then:

$$\phi = 180^0 - (2 * \beta) - \theta \qquad \text{(Eq-2)}$$

The center line in the reflected laser energy will be used as an approximation of the shortest distance that reflected laser energy would travel to intercept the base plane (d_{bp}). For simplicity it is assumed that the missile's trajectory is directly toward the PDRR ABL. The calculation of the center line distance of the reflected laser energy (d_{bp}) is:

$$d_{bp} = \frac{Y_m - Y_{bp}}{\text{SIN }(\phi)} \text{ km} \qquad \text{(Eq-3)}$$

where

Y_{bp} = altitude of base plane (10,000 ft).

Using the launch point as the reference, the location of the intercept of the center point of the reflected laser energy on the base plane (X_{bp}) is:

$$X_{bp} = X_m + \frac{Y_m - Y_{bp}}{\text{TAN }(\phi)} \text{ km} \qquad \text{(Eq-4)}$$

and the velocity of the center point of the reflected energy moving across the surface of the base plane (V_{bp}) at any time (t_n) is:

$$V_{bp}(t_n) = 1000 * \frac{X_{bp}(t_n) - X_{bp}(t_{n-1})}{t_n - t_{n-1}} \text{ m/sec} \qquad \text{(Eq-5)}$$

Diffuse Reflection

Diffuse reflections (subscript "d") from the missile form an approximately hemispherical pattern. The reflected diffuse radiance level (H_d) at a distance (d_d) from the target missile and exposure duration (t_d) is:

$$H_d = \frac{P_{HEL} * t_d * PS * TA * COS(\theta_v)}{\pi * d_d^2} \quad \text{joules/cm}^2 \qquad \text{(Eq-6)}$$

where

P_{HEL} = Power in the incident HEL beam at the missile in watts (joules/sec). Note, that the total radiant energy output is measured in joules and is equal to $P_{HEL} * t_d$

θ_v = Viewing angle from the vertical to the reflecting surface

PS = Percent of energy reflected expressed as a decimal

TA = Atmospheric Transmittance along reflected laser energy's path. For simplicity the TA for this analysis is assumed to be 1.

Eq-6 is similar to Eq-B15 of ANSI Z136.1-1993, and is valid when d_d is much greater than the spot-size of the HEL beam on the target. Let t_d equal 10 seconds, and H_d equal the MPE for an exposure duration of 10 seconds. From Table 5 of ANSI Z136.1-1993, this MPE value for a 1.315 μm laser is 0.405 joules per cm^2. The minimum eye-safe distance (d_{MPE}) can then be expressed as:

$$d_{MPE} = \sqrt{\frac{P_{HEL} * 10 * PS * TA * COS(\theta_v)}{\pi * 0.405}} \quad \text{cm} \qquad \text{(Eq-7)}$$

Assuming that a) the power of the HEL beam (P_{HEL}) is 1 megawatt of power at the target, b) all of the power is diffusely reflected (PS = 1), c) the atmospheric transmittance is 1, and d) the viewing direction is normal to the surface of themissile (the viewing angle is therefore 0 and $COS(\theta_v) = 1.0$), then d_{MPE} is approximately 2,800 cm (28 m).

Specular Reflection

The cone of expanding reflected specular energy (subscript "s") forms a pie-shaped wedge when viewed in cross section as it expands along the center angle of the reflected energy (Figure FA-3). An object on the base plane would be *irradiated* when impacted by the front of the expanding cone. Irradiation is defined as the radiant flux that impedes a unit area of surface, and is a power density expressed in watts/cm^2. The average irradiance level at any distance from the missile is the total power in the beam divided by the area of the beam (ANSI Z136.1-1993, Appendix B.4.2).

The area of the terminus of the expanding cone on the base plane can be approximated by a ellipse having a width (W_s) and a length (L_s) intersecting a sphere of radius d. For the analysis of the reflected specular energy this radius is d_{bp} (Figure FA-3). Note that both d_{bp} and the dimensions and location of the reflected energy are changing with time because of changing position of the target missile. The width, W_s, is a function of the diameter of the incident HEL beam (D_i), the diameter of the missile (D_m), and the distance to the base plane (d_{bp}) (Figure FA-4).

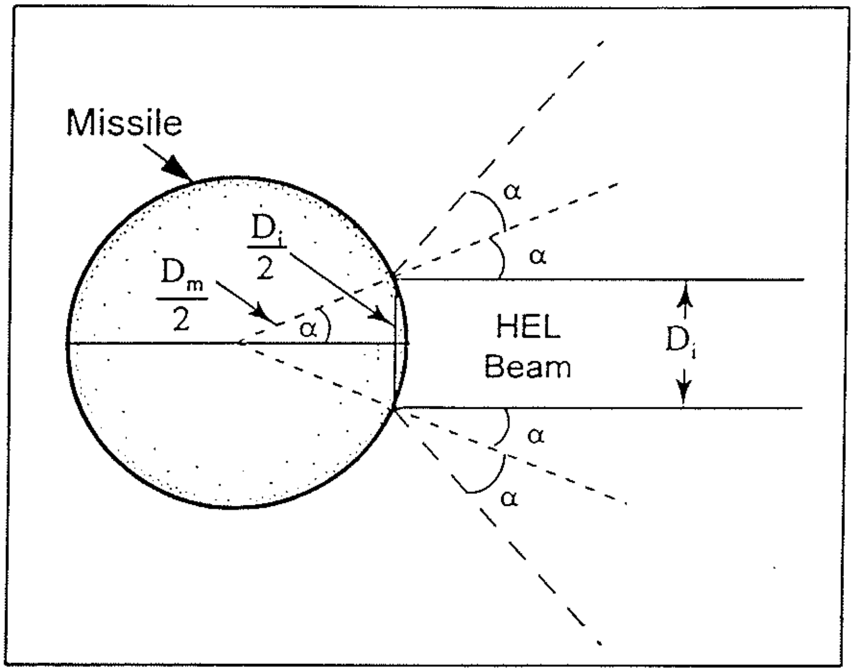


Figure FA-3. Projection of Reflected Energy on the Base Plane

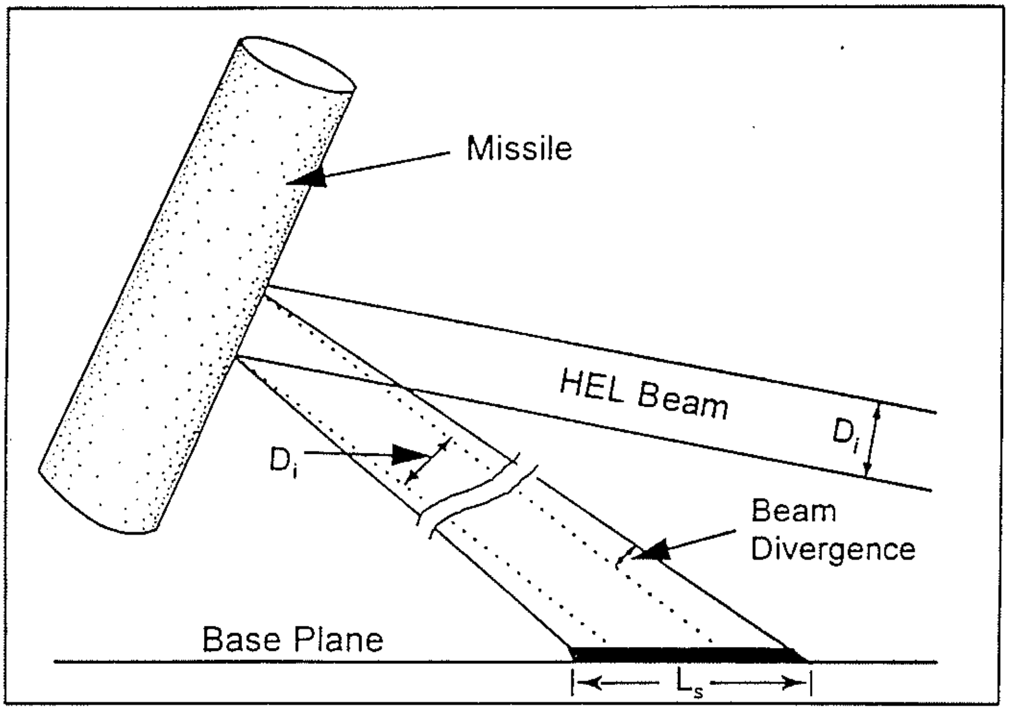


Figure FA-4. Spread of Reflected Energy due to Cylindrical Body of Missile

The spread angle of the reflected energy (α_w) from the cylindrical body of the missile (Figure FA-4) is approximately:

$$\alpha_w = 4\ \alpha = 4 * \text{ArcSIN}\left(\frac{D_i}{D_m}\right) \qquad \text{radians(Eq-8)}$$

The width of the pie-shaped wedge is a function of the circumference of a circle of radius d_{bp} and the angle α_w (Figure FA-3). The width of the pie-shaped wedge (W_s) is:

$$W_s = \left(\frac{\alpha_w}{2 * \pi}\right) * (2 * \pi * d_{bp}) \qquad \text{km(Eq-9)}$$

$$W_s = 1000 * \alpha_w * d_{bp} \qquad \text{meters(Eq-10)}$$

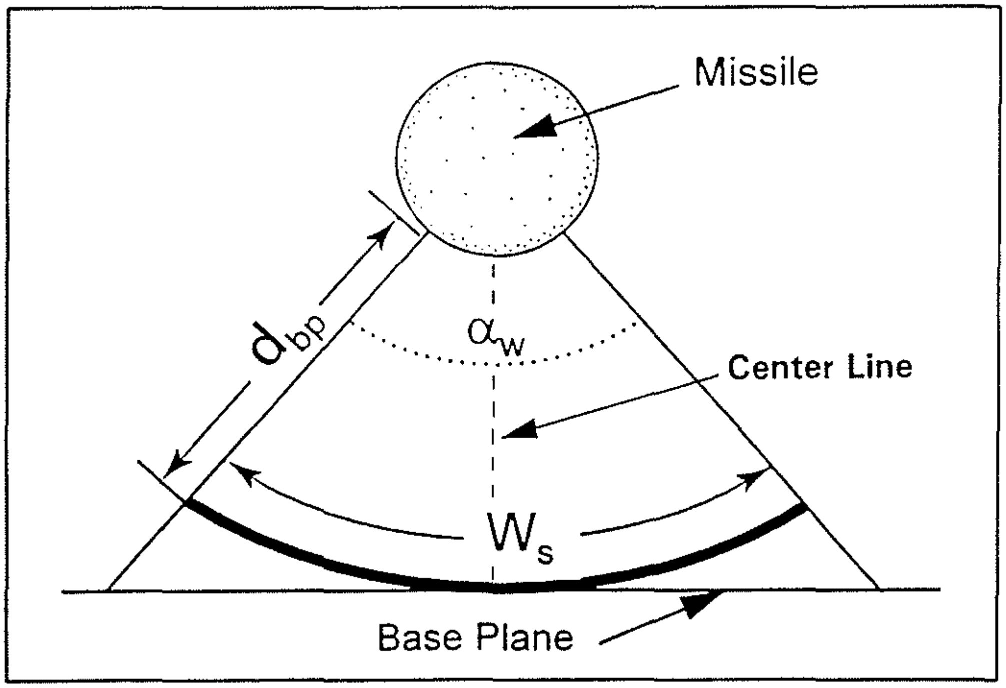
The length of the pie-shaped wedge (L_s) in the direction of the missile's flight path is a function of the reflected laser energy's beam divergence and the distance to the base plane (Figure FA-5). Because SIN $\theta \cong \theta$ radians when $\theta << 0.1$ radians, the equation for L_s can be simplified. Therefore, the length (L_s) is:

$$L_s = D_i + 2 * (1000 * d_{bp}) * \left(\frac{\lambda}{D_i}\right) \qquad \text{meters(Eq-11)}$$

where

λ=the wavelength of the incident HEL beam (1.315 μm)

ϕ = the angle of the reflected energy with respect to the horizon (Eq-2).



FA-5. Spread of Reflected Energy due to Beam Divergence

Then the maximum irradiance of the reflected specular laser energy (E_s) to a receptor at the point where the pie-shaped wedge intersects the base plane can be approximated by:

$$E_s = \frac{P_{HEL} * PS * TA}{\left(\frac{\pi * L_s * W_s}{4}\right) * SIN\left(\frac{D_i}{D_m}\right) * 10^4} \quad \text{watts/cm}^2 \text{ (Eq-12)}$$

The irradiance level calculated by Eq-12 is a conservative estimate because:

- The reflected energy density is greatest at the center line of the pie-shaped wedge. This is due to two factors.
  - The shortest distance from the target to the base plane is along the center line.
  - The incoming HEL energy density decreases per unit surface area on the missile as a function of the distance from the centerline of the missile. This is taken into account by the $SIN(D_i/D_m)$ term.
- It is assumed that 100 percent of the incoming energy is reflected (PS = 1).
- It is assumed that the atmospheric transmittance (TA) = 1.

Thus it can be seen from Eq-12 that the irradiance power density (E_S) from the reflection of incident laser energy (P_{HEL}) incident at the base plane is reduced as the area of the reflected ellipse on the base plane $[(\pi * L_S * W_S)/4]$ and the curvature of the missile $[SIN(D_i/D_m)]$ increase.

The exposure time (t_s) to reflected energy for a near stationary receptor on the base plane, represented by an ellipse of length L_{bp}, is:

$$t_s = \frac{L_{bp}}{V_{bp}} = \frac{L_s}{V_{bp} * SIN(\phi)} \quad \text{seconds(Eq-13)}$$

The radiance level density (H_s) is then the irradiance power density (E_s) multiplied by the exposure time (t_s):

$$H_s = E_s * t_s \quad \text{joules/cm}^2 \text{ (Eq-14)}$$

Glint Reflection

Glint reflection (subscript "g") is normally assumed to originate from a small, flat, highly-reflective surface with an area of one square centimeter. The first step in the analysis of the reflected laser energy is to calculate the energy density on the surface of the missile. Because the missile has a cylindrical body and is not perpendicular to the incident HEL beam, the surface area of a circular incident HEL beam is elliptical (subscript "e") in shape with length (L_e) and width (W_e). The length is a function of the incident angle of the HEL beam. The width will be assumed to be the diameter of the incident HEL beam (D_i). This produces a higher energy density and a more conservative estimate:

$$L_e = \frac{D_i}{SIN(\theta + \beta)} \quad \text{cm (Eq-15)}$$

$$W_e = D_i \quad \text{cm (Eq-16)}$$

The area of an ellipse A_e of an incident laser energy on the missile is:

$$A_e = \frac{\pi * L_e * W_e}{4} \quad \text{cm}^2 \text{ (Eq-17)}$$

The average irradiance power density on the surface of the missile (E_m) from the HEL beam can be approximated by:

$$E_m = \frac{P_{HEL}}{A_e} \quad \text{w/cm}^2 \text{ (Eq-18)}$$

This assumes an even distribution of energy in the incident HEL beam. Therefore the power in the one square centimeter glint area (P_g) is E_m. The reflected laser energy from a glint reflection will propagate from the glint surface as an expanding cone. The power density at a distance from the surface of the missile is a function of the distance, the wavelength of the laser energy, and the diameter of the glint surface (D_{gm}). For a one-square-cm glint, the diameter is:

$$D_{gm}=1.13 * 10^{-2} \text{ meters}$$

The diameter of the reflected glint laser energy (D_{gbp}) at distance d_{bp} is:

$$D_{gbp} = 1000 * \frac{2 * \lambda * d_{bp}}{d_{gm}} \quad \text{meters (Eq-19)}$$

and the area of the reflected laser energy on the base plane (A_{gbp}) is:

$$A_{gbp} = \frac{\pi * D_{gbp}^{\ 2}}{4} \quad \text{meters}^2 \text{ (Eq-20)}$$

The irradiance of the reflected laser energy (E_g) is:

$$E_g = \frac{P_g * PS * TA}{A_{gbp} * 10^4} \quad \text{w/cm}^2 \text{ (Eq-21)}$$

where

PS = percent of the energy reflected (assumed to be 100 percent, or 1 for this analysis)

TA = atmospheric transmittance (assumed to be 1)

Similar to the calculation of exposure time for specular reflected laser energy (Eq-13), exposure time for glint reflection (t_g) can be calculated as follows:

$$t_g = \frac{D_{gbp}}{V_{bp}} \quad \text{seconds} \quad \text{(Eq-22)}$$

The radiance (energy density) level is then the irradiance (power density) multiplied by the exposure time.

$$H_g = E_g * T_g \quad \text{joules/cm}^2 \quad \text{(Eq-23)}$$

Conclusions

The results of the above considerations are summarized in Tables FA-1 and FA-2 below. Table FA-1 is the analysis of the flight of the Lance missile and velocity of the reflected energy at the base plane. The B747 aircraft is assumed to be flying at an altitude of 40,000 ft (12 km) and at a distance of 200 km downrange from the launch point of the Lance missile. The missile reaches an altitude of 40,000 ft after 16 seconds of flight and would begin to be exposed to laser illumination at 18 seconds after launch. The main motor on the Lance missile burns for the first 5 to 6 seconds of flight and then the sustainer motor continues to provide thrust for an additional 25 seconds. Table FA-1 is divided into three sections. The first four columns describe the missile's flight, the next three columns describe the relationship between the B747 and the missile, and the last four columns describe the reflected energy's characteristics at the base plane. The center point of the reflected energy intercepts the base plane over the ocean at distances greater than 11 km (7 mi) downrange from the launch location, and is traveling at a velocity greater than 500 m/sec (over 1,100 mph).

Table FA-2 is divided into two sections. The first section describes the specular reflection of the HEL energy. The last two columns in the first section show that the radiance of the reflected energy is approximately two orders of magnitude below the maximum permissible exposure level defined in ANSI Z136.1-1993. The second section describes the glint reflection. The last two columns of the second section show that the reflected energy is approximately two orders of magnitude below the maximum permissible exposure level in all but the first two seconds. Figures F-4 and F-5 in Appendix F show the graphical representation of the results presented in this table.

Table FA-1. Flight Path of Lance Missile (130 km)

	Acceleration (m/sec2)	Flight Path Angle (deg/sec)				Time Increment (sec)	ABL Aircraft Altitude (km)	Seperation of ABL Aircraft from Launch Point (km)	Base Plane (BP) Altitude (km)		
t = 0,6	188.33333	-0.16666667				1	12	200	3		
t = 6,80	-6	-0.55835	0.033420213	0.042452703							
	0	53	10	-35							
	LANCE MISSILE FLIGHT PARAMETERS				ABL AIRCRAFT AND MISSILE			REFLECTED ENERGY AND BASE PLANE			
Time (sec)	Ground Range (km)	Altitude (km)	Velocity (m/sec)	Flight Path Angle (degrees)	Horizonal Distance from ABL Aircraft to Missile (km)	Delta Altitude between Aircraft and Missile (km)	Angle of HEL wrt Horizon (degrees)	Angle of Reflected Energy wrt Horizon (degrees)	Length of Reflected Energy Path to Base Plane (km)	Location of BP Intercept wrt Launch Point (km)	Velocity of BP Intercept Point (m/sec)
18	10.28	12.75	1,040.93	49.20	189.72	0.75	0.23	81.37	9.87	11.76	758.27
19	10.95	13.53	1,033.65	48.95	189.05	1.53	0.46	81.63	10.65	12.50	746.67
20	11.63	14.30	1,026.40	48.69	188.37	2.30	0.70	81.91	11.42	13.24	734.70
21	12.31	15.07	1,019.19	48.43	187.69	3.07	0.94	82.20	12.18	13.96	722.33
22	12.98	15.82	1,012.01	48.16	187.02	3.82	1.17	82.50	12.93	14.67	709.55
23	13.66	16.57	1,004.88	47.89	186.34	4.57	1.40	82.82	13.67	15.37	696.32
24	14.33	17.30	997.78	47.61	185.67	5.30	1.64	83.15	14.41	16.05	682.65
25	15.00	18.03	990.73	47.32	185.00	6.03	1.87	83.49	15.13	16.72	668.51
26	15.67	18.75	983.73	47.03	184.33	6.75	2.10	83.84	15.84	17.37	653.89
27	16.34	19.46	976.77	46.73	183.66	7.46	2.33	84.21	16.55	18.01	638.78
28	17.01	20.17	969.86	46.42	182.99	8.17	2.56	84.60	17.24	18.63	623.17
29	17.68	20.86	963.00	46.11	182.32	8.86	2.78	85.00	17.93	19.24	607.05
30	18.34	21.54	956.20	45.79	181.66	9.54	3.01	85.42	18.60	19.83	590.42
31	19.01	22.22	949.45	45.46	180.99	10.22	3.23	85.85	19.27	20.40	573.27
32	19.68	22.89	942.75	45.12	180.32	10.89	3.46	86.31	19.93	20.96	555.59
33	20.34	23.55	936.11	44.77	179.66	11.55	3.68	86.78	20.58	21.50	537.38
34	21.00	24.20	929.52	44.42	179.00	12.20	3.90	87.27	21.22	22.02	518.64
35	21.67	24.84	923.00	44.05	178.33	12.84	4.12	87.78	21.86	22.52	499.36

Table FA-2. Reflected Laser Energy Analysis for Lance Missile (130 km)

	Power of HEL Beam at Missile (watts)	Percent of HEL Energy Reflected	Transmission of Atmosphere	HEL Beam Diameter (m) ---------- Specular lamda/d	Missile Diameter (m) ---------- sin(alpha)	Reflected Energy Spread Angle (radians) (degrees)		MPE Constant for 1.05 to 1.4 X e-06 m wave length	HEL Wave Length (m) ---------- Glint lamda/d	Glint Area (cm2) ---------- Diameter of Glint (m)	10,000 pi/4		
t = 0,6	1,000,000	100%	100%	0.3	0.56	2.26		7.20E-02	1.32E-06	1	7854		
t = 6,80	1,000,000			4.38E-06	0.54	129.57			1.17E-04	1.13E-02			

	SPECULAR REFLECTION						GLINT REFLECTION						
Time (sec)	Width of Reflected Energy at BP (m)	Length of Reflected Energy at BP (m)	Maximum Reflected Energy Density at BP (w/cm2)	Exposure Time (sec)	Radiance of Reflected Energy (J/cm2)	MPE Table 5 & 6 (J/cm2)	Spot Length on Missile (m)	Glint Energy Density at Missile (w/cm2)	Diameter of Reflected Energy at BP (m)	Maximum Reflected Energy Density at BP (w/cm2)	Exposure Time (sec)	Radiance of Reflected Energy (J/cm2)	MPE Table 5 & 6 (J/cm2)
18	22,311	0.39	2.16E-02	5.16E-04	1.12E-05	2.46E-04	0.46	920.07	2.30	2.22E-02	3.03E-03	6.72E-05	9.30E-04
19	24,077	0.40	1.97E-02	5.32E-04	1.05E-05	2.52E-04	0.46	920.36	2.48	1.90E-02	3.32E-03	6.32E-05	9.97E-04
20	25,821	0.40	1.81E-02	5.50E-04	9.94E-06	2.59E-04	0.46	920.77	2.66	1.66E-02	3.62E-03	6.00E-05	1.06E-03
21	27,544	0.41	1.67E-02	5.68E-04	9.47E-06	2.65E-04	0.46	921.28	2.84	1.46E-02	3.93E-03	5.72E-05	1.13E-03
22	29,244	0.42	1.54E-02	5.88E-04	9.07E-06	2.72E-04	0.46	921.91	3.01	1.29E-02	4.25E-03	5.49E-05	1.20E-03
23	30,922	0.42	1.44E-02	6.08E-04	8.74E-06	2.79E-04	0.46	922.67	3.19	1.16E-02	4.58E-03	5.29E-05	1.27E-03
24	32,579	0.43	1.34E-02	6.29E-04	8.45E-06	2.86E-04	0.46	923.55	3.36	1.04E-02	4.92E-03	5.13E-05	1.34E-03
25	34,214	0.44	1.26E-02	6.51E-04	8.21E-06	2.94E-04	0.46	924.58	3.53	9.47E-03	5.27E-03	4.99E-05	1.41E-03
26	35,828	0.44	1.19E-02	6.75E-04	8.01E-06	3.02E-04	0.46	925.74	3.69	8.64E-03	5.65E-03	4.88E-05	1.48E-03
27	37,420	0.45	1.12E-02	7.00E-04	7.85E-06	3.10E-04	0.46	927.06	3.86	7.94E-03	6.04E-03	4.79E-05	1.56E-03
28	38,992	0.45	1.06E-02	7.27E-04	7.72E-06	3.19E-04	0.46	928.52	4.02	7.32E-03	6.45E-03	4.72E-05	1.64E-03
29	40,542	0.46	1.01E-02	7.56E-04	7.61E-06	3.28E-04	0.46	930.15	4.18	6.78E-03	6.88E-03	4.67E-05	1.72E-03
30	42,072	0.46	9.58E-03	7.87E-04	7.54E-06	3.38E-04	0.46	931.94	4.34	6.31E-03	7.34E-03	4.63E-05	1.81E-03
31	43,582	0.47	9.13E-03	8.20E-04	7.49E-06	3.49E-04	0.45	933.89	4.49	5.89E-03	7.84E-03	4.62E-05	1.90E-03
32	45,072	0.48	8.72E-03	8.56E-04	7.47E-06	3.60E-04	0.45	936.02	4.65	5.52E-03	8.36E-03	4.62E-05	1.99E-03
33	46,543	0.48	8.35E-03	8.95E-04	7.48E-06	3.73E-04	0.45	938.33	4.80	5.19E-03	8.93E-03	4.63E-05	2.09E-03
34	47,995	0.49	8.00E-03	9.38E-04	7.51E-06	3.86E-04	0.45	940.82	4.95	4.90E-03	9.54E-03	4.67E-05	2.20E-03
35	49,429	0.49	7.68E-03	9.85E-04	7.57E-06	4.00E-04	0.45	943.49	5.09	4.63E-03	1.02E-02	4.72E-05	2.31E-03

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Glossary of Symbols Used in Equations

Subscripts

a	subscript for aircraft
bp	subscript for base plane
e	subscript for ellipse
d	subscript for diffusive reflection
g	subscript for glint reflection
m	subscript for missile
s	subscript for specular reflection

Symbols

A_{gbp}	area of glint reflection at base plane
A_e	area of ellipse of incident laser energy on missile
C_c	constant (from ANSI Z136.1-1993) for calculating MPE
d	distance
d_{bp}	distance along center line of reflected laser energy from missile to base plane; radius of sphere from which ellipse of reflected laser energy is derived
d_d	distance of reflected diffuse laser energy from missile
d_{MPE}	minimum safe-eye distance
D	diameter
D_{gbp}	diameter of glint-reflected laser energy at distance d_{bp}
D_{gm}	diameter of glint surface
D_i	diameter of incident HEL beam
D_m	diameter of missile
E	irradiant energy
E_g	irradiance of glint-reflected laser energy
E_m	average density of irradiance power on surface of missile
E_s	maximum spectral irradiance of reflected laser energy
H	radiant energy
H_d	reflected diffuse radiance level
H_g	reflected glint radiant energy
H_s	specular radiance energy density
L_{bp}	length of reflected laser energy ellipse incident on base plane
L_e	width of reflected glint reflection laser energy ellipse
L_s	length of reflected specular laser energy ellipse

MPE	maximum permissible exposure
P_g	power of reflected laser energy of $1cm^2$ glint area
P_{HEL}	power in incident HEL beam at the missile (watts)
PS	percent of reflected energy
TA	atmospheric transmittance along reflected laser's energy path
t	time/duration
t_d	exposure time to diffuse reflection for receptor on base plane
t_g	exposure time to glint reflection for receptor on base plane
t_s	exposure time to specular reflection for receptor on base plane
V	velocity
V_{bp}	velocity of center point on base plane
W_e	width of reflected glint reflection laser energy ellipse
W_s	width of reflected spectral laser energy ellipse
X_a	ground range of aircraft
X_{bp}	ground range of reflected laser intercept point on base plane
X_m	ground range of missile
ΔX	ground range (distance) of aircraft from missile (Figure FA-1)
Y_a	altitude of aircraft
Y_{bp}	altitude of base plane
Y_m	altitude of missile
ΔY	altitude of missile above aircraft (Figure FA-1)
α_w	spread angle of reflected laser energy from cylindrical body of missile (Figure FA-5)
β	(beta) missile flight-path angle from horizontal (Figure FA-2)
θ	(theta) incident angle of laser energy from horizontal (Figure FA-2)
θ_v	viewing angle from the normal to a reflecting surface
λ	(lambda) wave length of laser
ϕ	(phi) center angle of reflected laser energy from horizontal (Figure FA-2)

REFERENCES

ANSI Z136.1, 1993. *American National Standard for Safe Use of Lasers (Z136.1)*

DoD (Department of Defense), 1993. Laser Range Safety: Military Handbook 828, prepared by the Department of Defense Laser System Safety Working Group, Arlington, Virginia.

Range Commanders Council, 1991. *Laser Range Safety,* White Sands Missile Range, New Mexico.

Sliney, D., and Wolbarsht, M., 1982. *Safety with Lasers and Other Optical Sources: A Comprehensive Handbook,* Plenum Press, New York, New York.

USAF, 1992. *Base-Level Management of Laser Radiation Protection Program,* prepared by Occupational and Environmental Health Directorate, Armstrong Laboratory, Brooks Air Force Base, Texas.

USAF, 1996. Memorandum from Dr. Paul Kennedy, Optical Radiation Division, Armstrong Laboratory, Brooks Air Force Base, Texas, regarding evaluation of ABL-PDRR safety analysis, June 19.

Van De Merwe, William P., and Marshall, W.J., 1986. "Hazardous Ranges of Laser Beams and Their Reflections from Targets", *Applied Optics*, Vol. 25, No. 5, March 1, 1986, published by Optical Society of America, New York, New York.

BIBLIOGRAPHY

Allen, R.G., J.A. Labo, and M.W. Mayo, 1990. *Laser Eye Protection*, S.P.I.E. Proceedings Volume 1207, Technical Conference on "Laser Safety, Eyesafe Laser Systems, and Laser Eye Protection," January 16-18, 1990, Los Angles, CA.

Cuneo, P.J., *ABL Program Eye Safety Calculations*, 19 January 1996, Laser Eye Safety Meeting, Kirtland AFB, NM

DoD, 1993. *Laser Range Safety*, Military Handbook 828, 15 April 1993.

Erkila, J. and S. Shakir, 1993. *Laser Radiation Hazard in Airplane-Based (ABL) Operations*, Letter to PL/SXX from RDA Logicon, Systems Technology Operations, Albuquerque, NM.

LANL, 1993. *Nonionizing Radiation, Laser Safety*, Technical Bulletin 501, March 22, 1993, Los AlamosNational Laboratory, NM.

USAF, 1980. *Occupational Health, Health Hazards Control for Laser Radiation*, AFOSH Standard 161-10, 30 May 1980.

USAF, 1995. *Eastern and Western Range 127-1, Range Safety Requirements.*

Weichel, H., 1990. *Laser Beam Propagation in the Atmosphere*, Tutorial Texts in Optical Engineering, Volume TT 3, SPIE Optical Engineering Press, Bellingham, WA.

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C DISTRIBUTION LIST

APPENDIX C
DISTRIBUTION LIST

AFFTC Technical Library
412 TW/TSDL
Edwards AFB, CA 93524

Antelope Valley Air Quality Management District
43301 Division St., Ste. 206
Lancaster, CA 93639-4409
Attn: Charles L. Fryxell. APCO
(Or) Bret Banks, Operations Manager

Bureau of Land Management
Barstow Area Office
2601 Barstow Road
Barstow, CA 92311-3221

Bureau of Land Management
Ridgecrest Area Office
300 S. Richmond Road
Ridgecrest, CA 93555-4436

California Department of Fish and Game
1416 Ninth Street
Sacramento, CA 95814

California Department of Parks and Recreation
P.O. Box 942896
Sacramento, CA 94296

City of Lancaster
Planning Department
44933 N. Fern Ave.
Lancaster, CA 93534

Congressman McKeon
Antelope Valley Field Office
1008 W. Avenue M-14 #E-1
Palmdale, CA 93551

Congressman Thomas
4100 Empire Dr.
Bakersfield, CA 93309

Edwards AFB Base Library
95 SPTG/SVMG
5 West Yeager Blvd.
Building 2665
Edwards AFB, CA 93524-1295

Federal Aviation Administration
Western Pacific Region
Attn: Charles Lieber
Airspace Management Branch
15000 Aviation Boulevard
Lawndale, CA 90261

Inyo County Free Library
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PO Box 568
Death Valley, CA 92328

Jerry Schwartz
Environnemental Lead
Surveillance Systems Engineering Group
FAA, AND-402
800 Independence Avenue SW, Room 511
Washington, DC 20591

John O'gara
Head of Environmental Planning
Environmental Office
Code 8G0000D
#1 Administration Circle
Naval Air Weapons Station
China Lake, CA 93555

Kern County APCD
Attn: Thomas Paxson, P.E.
2700 M Street, Suite 302
Bakersfield, CA 93301-2370

Kern County Department of Planning
and Development Services
2700 M Street, Suite 100
Bakersfield, CA 93301-2323

Kern County Library
Boron Branch
26967 20 Mule Team road
Boron, CA 93516

Kern County Library
California City Branch
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California City, CA 93505

Kern County Library
Mojave Branch
16916-1/2 Highway 14
Mojave, CA 93501

Kern County Library
Ridgecrest Branch
131 East Las Flores Ave
Ridgecrest, CA 93555

Kern County Library
Wanda Kirk Branch (Rosamond)
3611 Rosamond Boulevard
Rosamond, CA 93560

Kern River Valley Library
7054 Lake Isabella Boulevard
Lake Isabella, CA 93240
Attn: Karen Liefield, Branch Supervisor

Los Angeles County Library
Lancaster Branch
601 W. Lancaster Boulevard
Lancaster, CA 93534

Mojave Desert AQMD
14306 Park Ave.
Victorville, CA 92392-2310
Attn: Charles L. Fryxell, APCO

Muhammad Bari
Director of Public Works
HQ NTC Ft. Irwin
Attn: AFZJ-PW-EV
PO Box 105097
Building 285
Fort Irwin, CA 92310-5097

Native American Heritage Commission
915 Capital Mall, Room 364
Sacramento, CA 95814

Office of Historic Preservation
State Historic Preservation Officer
PO Box 942896
Sacramento, CA 94296-0001

Office of Planning and Research
California State Clearinghouse
PO Box 3044
Sacramento, CA 95812-3044

San Bernardino County
Land Use Services Department
Planning Division
385 N. Arrowhead Ave., 1st Floor
San Bernardino, CA 92415-0182

Sierra Club
Antelope Valley Group
P.O. Box 901875
Palmdale, CA 93590

Timbisha Shoshone Tribe
P.O. Box 206
Death Valley, CA 92328-0206
Attn: Pauline Esteves, Chairperson

USDA Forest Service
Pacific Southwest Region
Sequoia National Forest
900 West Grand Avenue
Porterville, CA 93257

U.S. Department of the Interior
National Park Service
Death Valley National Park
PO Box 579
Death Valley, CA 92328

U.S. Department of the Interior
Fish and Wildlife Service
Ventura Field Office
2493 Portola Road, Suite B
Ventura, CA 93003-7726

U.S. Environmental Protection Agency
Region IX
EIS Review Section
75 Hawthorne Street
San Francisco, CA 94105

US Senator Barbara Boxer
501 I Street, Suite 7-600
Sacramento CA 95814

US Senator Diane Feinstein
United States Senate
331 Hart Senate Office Building
Washington, DC 20510

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D EXAMPLE PHOTOS OF TARGET AREAS

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Example of Existing Target Board at Downfall Complex

Target Area at Mt. Grinnel

Target Area at Haystack Butte

Target Area at Mt. Mesa

PB-13 Target Area

Target Area at Jackrabbit Hill

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E RESPONSE TO COMMENTS

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Response to Public/Agency Comments on Draft Environmental Assessment for High Energy Lasers at Edwards AFB		
Comment #	Commenter	Comment
Response		
1	Kern County APCD, David L. Jones	The District is aware aircraft pilots and support staff at Edwards Air Force Base (EAFB) have a high degree of skill, and catastrophic occurrences from equipment from EAFB are rare. However, the District believes an assessment of a catastrophic release of toxic (hazardous) air contaminant emissions as a result of an aircraft failure is warranted. The District believes manpower and equipment responses and agency notifications should be included in this EA.
Thank you for your response. The Air Force will update the statement on page 4-43 to read, "If a crash or catastrophic release associated with laser testing occurred in Region 1 or Region 2, the Air Force would be responsible for assessing and cleaning up the crash site to pre-crash conditions. This would include cleaning up hazardous wastes and disposing of the solid waste debris; thus, there would be a less than significant hazardous or solid waste impact. The Air Force, Army, and Navy, as members of the R-2508 Complex Control Board, have a letter of agreement with BLM, Inyo National Forest, Sequoia National Forest, Sequoia and Kings Canyon National Parks, and Death Valley National Park that stipulates DoD responsibilities in the unlikely event that an accident involving DoD resources occurs on federal lands managed by these agencies. Because the probability of a crash would be extremely low, impacts on hazardous of solid waste would not be anticipated." In regards to the request for an assessment of toxic (hazardous) air contaminant emissions, the Air Force does not agree that an assessment is warranted or required. NEPA does not require that an assessment for unplanned events (catastrophic releases) be included as a part of this assessment. NEPA states "the discussion will include the environmental impacts of the alternatives including the proposed action, any adverse environmental effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented." A catastrophic release can be avoided if procedures and test plans are followed and implemented as proposed. Unplanned accidents at Edwards AFB are extremely rare. Only the best Air Force, Navy, and Army pilots are allowed to become test pilots because they are proven professionals that rarely make catastrophic mistakes. Notification of any crash or other		

<table>
<tr><th colspan="3">Response to Public/Agency Comments on Draft Environmental Assessment for High Energy Lasers at Edwards AFB</th></tr>
<tr><th>Comment #</th><th>Commenter</th><th>Comment</th></tr>
<tr><th colspan="3">Response</th></tr>
<tr><td colspan="3">event resulting in the catastrophic release of toxic (hazardous) air contaminant emissions would be required and accomplished according to current federal and state requirements. Any accidental release reporting would be accomplished under SARA Title III (EPCRA) requirements. Accidental release means an unanticipated emission of a regulated substance or other extremely hazardous substance into the ambient air from a stationary source. The aircraft laser tests are conducted from mobile sources.</td></tr>
<tr><td>2</td><td>Department of Toxic Substances Control, John Harris</td><td>Section 3.6.1.2, page 3-42, Hazardous Waste: DTSC recommends that Edwards Air Force Base Environmental Management staff be consulted to ensure that all waste products associated with this project are properly characterized, stored, handled, and disposed.</td></tr>
<tr><td colspan="3">Thank you for your response. Test plans would be reviewed by 95ABW/CEV. In Section 4.6.1.1 it states that hazardous materials associated with chemical and solid state lasers…would be managed according to established procedures at Edwards AFB. Lines 9 - 12 on page 4-44 state that POLs are managed by Air Force instruction. When laser test and evaluation aircraft are on the flightline, hazardous materials and hazardous waste are managed under the requirements of AFFTC Plan 32-7042, Hazardous Waste Management Plan. The Environmental Management staff (95 ABW/CEV) is responsible for the oversight of both hazardous materials and hazardous waste. The Air Force will add the following statement on page 4-44 line 12 to state that “The 95ABW/CEV (Environmental Management staff) has oversight responsibilities and will be consulted to ensure that the proper characterization, storage, handling, and disposal of all waste products (HM, HW, and solid waste) associated with laser test programs conducted from Edwards AFB occurs.”</td></tr>
<tr><td>3</td><td>State of California, Office of Planning and Research,</td><td>The State Clearinghouse submitted the above named Joint Document to selected state agencies for review. The review period closed on June 30, 2006, and no state agencies submitted comments by that date. This letter acknowledges that you have complied with State Clearinghouse review requirements for draft environmental documents, pursuant to the California Environmental Quality Act.</td></tr>
</table>

Response to Public/Agency Comments on Draft Environmental Assessment for High Energy Lasers at Edwards AFB

Comment #	Commenter	Comment
		Response
	State Clearinghouse and Planning Unit, Terry Roberts	
Noted.		

KERN COUNTY AIR POLLUTION CONTROL DISTRICT
DAVID L. JONES, APCO

June 26, 2006

Mr. Gary Hatch
Environmental Public Affairs
Edwards Air Force Base
95ABW/PAE, 5 E. Popson Avenue, Building 2650A
Edwards AFB, California 93524-8060

SUBJECT: Comments Regarding the Draft Environmental Assessment for Testing and Evaluation of Directed Energy Systems Using Laser Technolog

Dear Mr. Hatch:

The Kern County Air Pollution Control District (District) is in receipt of the Environmental Assessment (EA) report for Testing and Evaluation of Directed Energy Systems Using Laser Technology. The report includes a large amount and data and seems complete in most respects.

The District is aware aircraft pilots and support staff at Edwards Air Force Base (EAFB) have a high degree of skill, and catastrophic occurrences from equipment from EAFB are rare. However, the District believes an assessment of a catastrophic release of toxic (hazardous) air contaminant emissions as a result of an aircraft failure is warranted. The District believes manpower and equipment responses and agency notifications should be included in this EA.

Thank you for notifying the KCAPCD of the proposed project. Should you have any questions, please telephone Glen Stephens of our office at (661) 862-5250.

Sincerely,

David L. Jones
Air Pollution Control Officer

DLJ: GES: dg
H:\CEQA\Comments 2006\6-26gs EAFB draft EA 366.doc

Bakersfield Office: 2700 "M" Street, Suite 302, Bakersfield, CA 93301-2370
Phone (661) 862-5250 -- Fax (661) 862-5251
www.kernair.org – kcapcd@co.kern.ca.us
Mojave Office: 1775 Highway 58, Mojave, CA 93501-1945 – Phone (661) 824-7085

Department of Toxic Substances Control

Maureen F. Gorsen, Director
8800 Cal Center Drive
Sacramento, California 95826-3200

Linda S. Adams
Secretary for
Environmental Protection

Arnold Schwarzenegger
Governor

June 29, 2006

Mr. Gary Hatch
95 ABW/CEVX
5 East Popson, Building 2650A
Edwards Air Force Base, California 93524-1130

COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE TESTING AND EVALUATION OF DIRECTED ENERGY SYSTEMS USING LASER TECHNOLOGY (STATE CLEARINGHOUSE #2006054003), EDWARDS AIR FORCE BASE, CALIFORNIA (May 2006)

Dear Mr. Hatch:

The Department of Toxic Substances Control (DTSC) has completed our review of the above referenced document, received by the Office of Military Facilities on June 20, 2006. DTSC has the following general comment:

Section 3.6.1.2, page 3-42, Hazardous Waste: DTSC recommends that Edwards Air Force Base Environmental Management staff be consulted to ensure that all waste products associated with this project are properly characterized, stored, handled, and disposed.

Should you have any questions, please contact me at (916) 255-3683.

Sincerely,

John Harris
Project Manager
Hazardous Substances Scientist
Office of Military Facilities

STATE OF CALIFORNIA
Governor's Office of Planning and Research
State Clearinghouse and Planning Unit

Arnold Schwarzenegger
Governor

Sean Walsh
Director

July 3, 2006

Gary Hatch
U.S. Air Force
95th ABW/CEVX, 5 E. Popson Avenue
Building 2650A
Edwards AFB, CA 93524-1130

Subject: Testing and Evaluation of Directed Energy Systems Using Laser Technology, Edwards Air Force Base, California
SCH#: 2006054003

Dear Gary Hatch:

The State Clearinghouse submitted the above named Joint Document to selected state agencies for review. The review period closed on June 30, 2006, and no state agencies submitted comments by that date. This letter acknowledges that you have complied with the State Clearinghouse review requirements for draft environmental documents, pursuant to the California Environmental Quality Act.

Please call the State Clearinghouse at (916) 445-0613 if you have any questions regarding the environmental review process. If you have a question about the above-named project, please refer to the ten-digit State Clearinghouse number when contacting this office.

Sincerely,

Terry Roberts

Terry Roberts
Director, State Clearinghouse

1400 TENTH STREET P.O. BOX 3044 SACRAMENTO, CALIFORNIA 95812-3044
TEL (916) 445-0613 FAX (916) 323-3018 www.opr.ca.gov